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Pullman, Washington
June 28, 1929

FOREWORD

ERNEST O. HOLLAND

Seven years ago there were called together twelve representative members of the college faculty in the fields of pure science and the arts, to consider the desirability of forming a society which would be interested in research work in these fields. As a result of this conference there was established the Research Council which, from the beginning, has had two specific purposes:

First, to encourage a larger number of the best students of the State College to continue their studies after graduation and complete the requirements for an advanced degree.

Second, to adjust the teaching loads of members of the faculty demonstrating distinct capacity for research work so that they might have opportunity to carry on scientific investigations. These faculty members were assured that if possible they would also be placed on the eleven months' basis, with increased compensation, so that during the summer period they would be free to devote full time to research.

As a result of the reduction of teaching schedules and the lengthening of annual service for a limited number of the faculty, much important research work has been carried on; also many valuable scientific papers have been presented to the Research Council and a fairly large number of these papers have been published in the leading scientific journals of the country.

For centuries the leading colleges and universities of this and other countries have given freely to the world the results of their scientific investigations. The publication, "Research Studies", will enable the State College of Washington to offer its contributions to the advancement of truth and make them available to the scientific workers wherever they may be found.

President's Office, *April 24, 1929.*
State College of Washington.

THE SOURCE OF THE SWAUK PLACERS

JOHN PRENTISS THOMSON

(Received for publication March 13, 1929)

This paper attempts to explain the origin and to trace the latter part of the history of the gravels which make up the benches and terraces occurring along Swauk and Williams Creeks in north central Washington.

The Mount Stuart Quadrangle, an area of 400 square miles, in whose central part these gravels occur, has been mapped by the U. S. Geological Survey. That portion with which this paper is concerned is bounded on the north by Ingalls Creek, on the east by Table Mountain, on the south by the western rim of Kittitas Valley, and at the west by the 120°50′ meridian.

THE SWAUK BASIN

The principal deposits constituting the Swauk Placers are found along Swauk and Williams Creeks, which with their tributary streams drain the Swauk Basin.[1] This basin, which is shown in figure 1, is about 20 miles northwest of Ellensburg and 12 miles east of Cle Elum. It may be roughly bounded on the north by the divide marked by Blewett Pass, on the east by the rugged slopes of Table Mountain, on the south by the northern rim of Kittitas Valley, and on the west by the northward trending Teanaway Ridge.

The placer gravels occur in Recent and Pleistocene deposits, for 12 miles along Swauk Creek, for about 4 miles along Williams Creek, and on several of their tributaries.

An average elevation of about 6,000 feet marks the eastern boundary of the basin. Heights over 5,000 feet are rarely found along the divides to the north and west, while the elevations at the south are low, scarcely over 3,800 feet. Within the basin the hills rise abruptly from the streams, and the area as a whole is prominently dissected.

Sedimentary and igneous types make up the rocks in the basin and attain a thickness of approximately 5,000 feet. Sandstone, shale, and conglomerate, named in the order of their abundance, are grouped

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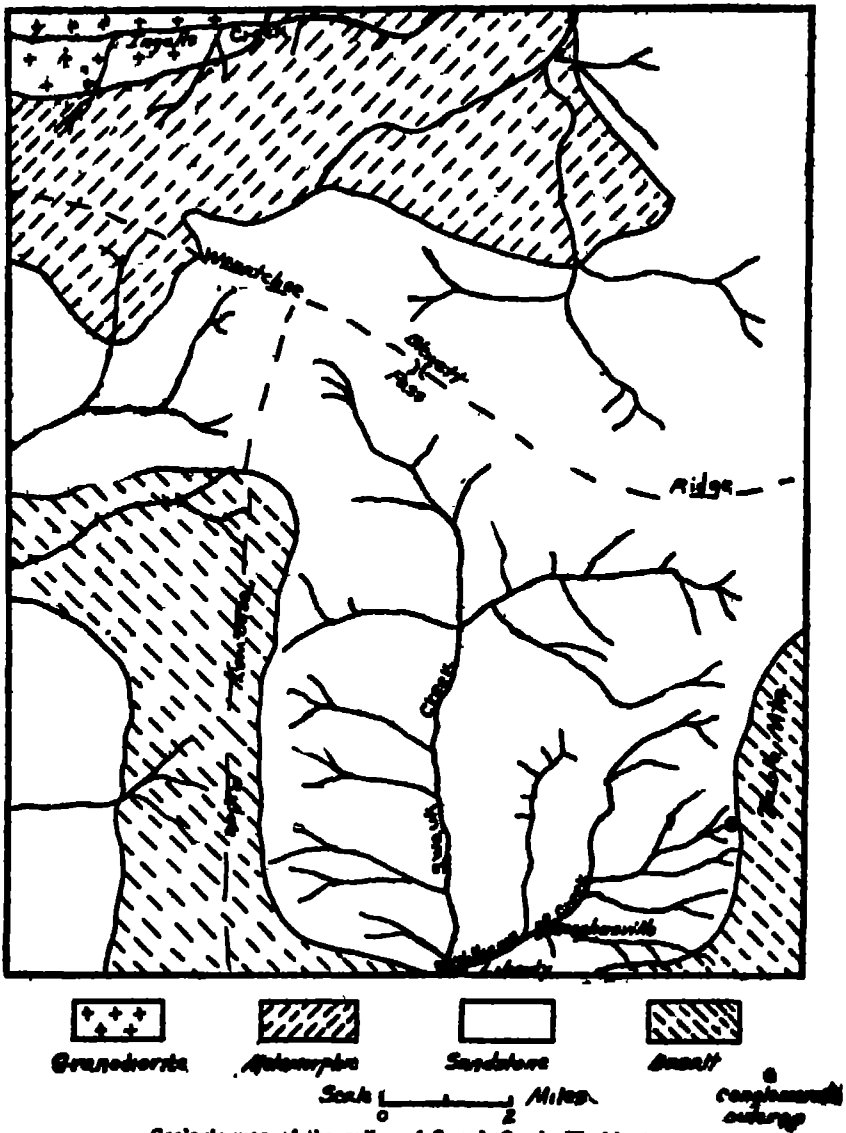
[1] For details of mining operations on Swauk Creek see Washington State Engineer 3: 8, 16, 1928; Mining Truth, July 16, 1928 and February 1, 1929.

Figure 1



Geologic map of the valley of Swauk Creek, Washington under the name Swauk Formation. Basic igneous flows, and their associated dikes, which are of two distinct ages, comprise the second group.

To the north of the basin, near Ingalls Creek is a group of much older formations, all metamorphic, with the exception of the Mount Stuart Granodiorite, and furnishing scant evidence as to their origin. The granodiorite, presumably of batholithic origin, reaches an elevation of 9,400 feet in the serrate summit of Mount Stuart. This peak, which may represent the center of this Pre-Tertiary intrusion, is nearly surrounded by a belt of highly crumpled and faulted formations mapped in Figure 1 as metamorphic rocks.

PLACER GRAVELS OF THE SWAUK BASIN

The gravels composing the terraces in this basin, termed the Swauk Placers, were transported and deposited during Pleistocene time. The great load carried was the outstanding feature of the Pleistocene rivers that drained the basin. Many other streams flowing in central and northeastern Washington during this period show, by the enormous terraces and benches now topographically prominent, that they were heavily loaded, needing only a slight decrease in their transporting power to cause them to drop thousands of cubic yards of debris.

This feature was noted[8] by Russell, who says, "The melting of the snow on the mountains, together with the rainfall, must have swollen not only the streams flowing from the glaciers, but others as well, so that all the streams had their volumes increased to a marked extent during the Glacial epoch Now, as is well known, an increase in the volume of a stream means greater energy available for transportation, and, other conditions remaining unchanged, an increase in its power to corrode. On this ground alone we might justly assume that the streams of Washington and adjacent regions should have greatly deepened their channels during the Glacial epoch instead of deeply filling them. Streams fed by glaciers, however, as is also well known from the study of many existing examples, are usually supplied with more debris than they can transport, or are overloaded, and consequently aggrade their channels For this reason we seem justified in assuming that the streams flowing from the glaciers of the Cascades and neighboring mountains were overloaded during the Glacial epoch, in spite of their previously eroded valleys and canyons."

The old Swauk Placers, although not striking features of the topography, are recognizable in the form of benches and terraces lying 10 to 15 feet above the present channels. From the mouth of First

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[8] I. C. Russell, U. S. Geol. Surv. Ann. Rept. 20: 81-210, 1898-99.

Creek north to Iron Creek, the Swauk is marked by old channel remnants on one side or the other of the present canyon for a distance of nearly 12 miles. Williams Creek, the principal tributary of the Swauk, for four miles above Liberty, shows similar deposits.

The gravels are coarse, most of the material being over 4 inches in diameter while boulders two feet in diameter are not uncommon. The material is very poorly sorted and displays little stratification. Occasional beds of sand, one foot or less thick, are found at irregular intervals interbedded with fine and coarse gravels.

A large assortment of rock materials can be found in these gravels representing the several formations exposed in the northern part of the area shown in figure 1. No record of any fossils has been made from the Pleistocene gravels.

Coarse gold is present in the Swauk Placers, its location suggesting evidence concerning the amount of sorting that took place during deposition. Large nuggets up to 12 ounces have been mined from the gravels five feet above the bedrock surface, which fact warrants the inference that the sorting action of these old rivers must have been slight.

In attempting to find the source of the Swauk Placers, the composition of the gravel deposits seems to be the line of most logical attack. Russell states,[8] "There are suggestions that Swauk Creek originally had its source on the great Wenatchee uplift and flowed across the Swauk dome, but at a later stage was beheaded. Swauk Creek now drains a basin composed entirely of standstone, shale, basaltic dikes and sheets and volcanic lapilli. There are no outcrops of acid igneous rocks or of serpentine, gneiss, granite, etc., within the rim of the present hydrographic basin; yet in the coarse gravel and boulders along the sides and forming the bed of the present stream there are waterworn stones, some of them between 1 and 2 feet in diameter, that have been derived from the crystalline areas about Mount Stuart. At one locality an estimate based on an examination of the cleanly washed boulders at a hydraulic placer mine gave from 10 to 12 per cent of large stones that are foreign to the Swauk Creek Basin, but agree lithologically with the crystalline terranes in the central portion of the Wenatchee Mountains. These are considered as representing ancient stream transportation, as no such boulders occur in the sedimentary beds within the present reach of Swauk Creek, and there is no evidence of glaciers ever having entered that basin."

During the writer's study of the placer gold of this district, in July 1928, the source of the gravels was considered important as an indication of the source of the gold. A pebble count of the material exposed in Bryant Tunnel, half a mile south of Liberty, one of the early drift mines which penetrated the ancient gravels, showed the following percentage composition of the placers at this point. Of 319 rocks examined, average size 1" in diameter, 182 were basalt, 68 Swauk sandstone, 30 andesite, 12 diorite, 8 diabase, 3 quartzite, 2 granodiorite, 1 gneiss, and 11 metamorphic rocks of uncertain origin.

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[8] Mem. p. 148.

This pebble count did not exactly duplicate the findings of Russell but it did show a sufficient number of rock types not observed in place in the basin to justify the expenditure of considerable time in trying to locate their source. Finding that the Swauk formation included a conglomeratic phase, an examination of this part of the series was made near the headwaters of Williams Creek at an elevation of about 4,600 feet, on the western slope of Table Mountain. In an outcrop of conglomerate which rose 60 feet vertically from the floor of the gulch were found pebbles and boulders that corresponded identically with the rock found in the placers and termed "foreign wash" by Russell. This great mass of conglomerate is so situated that, as the pebbles and boulders were loosened, they were accessible to, and could have been transported by, Pleistocene torrents to the bars and terraces where they are found today.

CONCLUSION

The Swauk formation is composed of debris from granitic and metamorphic rocks which probably came in Eocene time from the area north of Swauk Basin; fragments of these materials were reworked in Pleistocene time along with fragments of igneous rocks to form the terrace deposits of the Swauk drainage.

It thus seems clear that for the formation of the Swauk Placers, deposited by Pleistocene streams, no addition of material from formations other than those then exposed in the basin need be assumed.

Department of Geology,
State College of Washington.

PERMEABILITY OF THE INTESTINAL MUCOSA TO NATIVE FECAL BACTERIA

LaVerne Almon Barnes

(Received for publication February 15, 1929)

Vaccines made from cultures of members of the *Escherichia coli*[1] group isolated from the intestinal tract have been used for various purposes. Thus, they have been employed by Satterlee (1), and Torrey and Rahe (2), in treating certain cases of intestinal toxemia; by Jackson and Pickard (3) in eczema; by Went (4) in colitis, and by Kauntze (5) in rheumatoid arthritis, rheumatism, and allied conditions. The authors in each case reported beneficial results from the treatment. These vaccines were given subcutaneously. No data upon the oral administration of colon vaccines were found. The effectiveness of this method of administering the vaccine will, to some extent, be determined by the permeability of the intestinal mucosa. In determining the value of local immunity, it is desirable to compare the effectiveness of various methods of vaccination in stimulating the production of agglutinins for native members of the *Escherichia coli* group.

The following experiments were designed, therefore, to determine whether the oral adminstration of autogenous colon vaccines will result in an increase in the agglutination titer for these organisms, and whether it is just as effective as the subcutaneous and intravenous methods.

EXPERIMENTAL DATA

Fresh feces from each rabbit were suspended in sterile broth or peptone water. After thorough mixing, Gram stains were made of smears from the suspensions to determine the predominating type of organism. From 40 per cent to 90 per cent of the organisms observed

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1. **Escherichia coli (Escherich, 1886) Castellani and Chalmers, 1919. Synonyms: Bacterium coli commune Escherich, 1886, Bacillus coli communis (Escherich) Sternberg, 1892, Bacterium coli (Escherich) Lehmann and Neumann, 1896; Bacillus coli (Escherich) Migula, 1900. In the same group is Escherichia communior (Durham). Synonyms: Bacillus coli communior Durham, 1900; Bacterium communior, Holland, Committee, S A. B, 1920**

were Gram negative short rods. Streak plates were then made on Eosin-Methylene-Blue agar from each fecal sample, and colonies typical for members of the *Esch. coli* group were transferred to agar slants. Gram stains and cultural characteristics indicated pure cultures of the coli group, the majority of which were of the saccharose-fermenting type. Agglutination tests were conducted with the organism isolated from each rabbit and the homologous serum.

Vaccines were made from twenty-four-hour growths of each organism on isotonic agar, and suspensions were made in sterile physiological saline. The vaccines were standardized by turbidity comparisons, the estimated number of organisms present being two billion per cubic centimeter. The vaccines were killed by heating at 70° Centigrade for one hour. Sterility tests were negative. No preservative was added.

Five rabbits were used in the orally vaccinated group. The vaccine was introduced through a small rubber catheter attached to a syringe. Each animal received a total of 10 doses of 10 cubic centimeters each, making a total of approximately 200 billion organisms. The vaccine was given on alternate days. No attempt was made to erode the intestinal mucosa before administering the vaccine. Food was kept before the animals at all times. Each animal in the subcutaneous and intravenous groups received 3 doses of 1 cubic centimeter each, making an estimated total of 6 billion organisms. Four rabbits were used in the subcutaneous group, and three in the intravenous series.

Agglutination tests were conducted on each animal after a rest period of eleven days following the last dose of vaccine. Live organisms were used in all agglutination tests.

The results of vaccination by the three methods employed are given in Table 1.

TABLE 1

Agglutinins in the Blood of Rabbits following Oral, Subcutaneous, and Intravenous Vaccination with Native Fecal Bacteria

Rabbit	Normal Titer	Doses Vaccine	Quantity of Vaccine	Agglutinin Titer
Oral Group			Ccs.	
1	——	10	100	1:384
2	——	10	100	——
3	1:12	10	100	1:48
4	1:24	10	100	1:48[9]
5	1:48	8	100	1:768
Subcutaneous Group				
6	1:12	3	3	1:192
7	——	3	3	1:12
8	——	3	3	1:768
9	1:6	3	3	1:48
Intravenous Group				
10	1:12	3	3	1:384
11	——	3	3	1:768
12	1:24	3	3	1:768

Certain of the animals used in the above experiment were given further vaccination to determine whether continued administration of the vaccine would result in an increased agglutinin production. The treatment and results are shown in Table 2.

TABLE 2

Agglutinins in the Blood of Rabbits Subjected to further Vaccination by the Oral and Subcutaneous Methods

Rabbit	Group	Previous Titer	Additional Doses	Method of Vaccination	Additional Quantity of Vaccine	Agglutinin Titer
					Ccs.	
1	oral	1:384	1	oral	10	1:768
2	oral	——	1	oral	10	——
6	subcu.	1:192	1	subcu.	2	1:768

Rabbit 2 was later given 3 subcutaneous doses of the vaccine in 1 cc. amounts, making a total of 226 billion organisms. Following the rest period, the agglutination titer was found to be positive in a serum dilution of 1:768.

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[9] This animal died on the day the last dose of vaccine was given from causes other than the vaccine, and an agglutination test was made on this day.

DISCUSSION

From the results in Table 1, it appears that there usually are agglutinins for native members of the *Esch. coli* group in the blood of normal rabbits, but, when present, they are weak. This is further evidence that the intestinal mucosa may vary in its permeability to intestinal organisms. Kraus and Loew (6) believe that the sera of newborn animals possess no agglutinating power for intestinal organisms. Kauntze (5) believes that there are no agglutinins for coliform bacilli in the blood of healthy human beings. Zinsser states, however, that the normal sera of adult animals and man will often agglutinate these organisms in dilutions as high as 1:10 or 1:20 (6). This condition, he says, is possibly referable to the habitual presence of these organisms within the body. The observations of Kraus and Loew support this assumption. The experiments reported in the present paper also favor this view.

It may also be noted that the intravenous method of vaccination resulted in more uniformly high titers than the other two methods used. This may be due to the antigen reaching the receptive cells in greater concentration. While in these experiments there was no significant difference between the results obtained in the oral and subcutaneous groups, the subcutaneous method has been shown to be superior to the oral method in the case of typhoid immunization (7). The fact that rabbit 2 failed to produce agglutinins demonstrable in the blood stream as a result of oral vaccination, but showed a relatively high agglutination titer after subsequent subcutaneous vaccination, indicates that the subcutaneous method is also more effective in the case of immunization with coli. Although this animal does not furnish sufficient evidence upon which to base conclusions, it serves to indicate that oral introduction of organisms may result in an imperviousness of the intestinal mucosa as claimed by Besredka (8). The negative results in this animal in the normal agglutination tests, and after oral vaccination, may have been due to an inherent impermeability or one acquired as a result of the constant presence of the organisms in the intestinal tract.

CONCLUSIONS

Agglutinins in the blood of normal rabbits for certain native members of the *Esch. coli* group are either absent or very weak. The intestinal mucosa does not in all cases become impervious as a result of constant exposure to the organisms in the fecal mass. Oral vaccination results in an increase in the agglutinin titer in some rabbits but not in others. The oral method in some rabbits is just as effective in stimulating the production of agglutinins as the subcutaneous method. Intravenous vaccination brings about a more uniform rise in agglutination titer than the subcutaneous and oral methods. These results have a bearing on Besredka's theory of local immunity.

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Bacteriological Laboratories,
State College of Washington.

THE FLOWERING AND FRUITING HABITS OF LOMATIUM[*]

EDITH HARDIN

(Received for publication January 5, 1929)

Early in the spring of 1927, some interesting as well as puzzling observations led to the belief that further investigation of the flowering and fruiting habits of certain species of *Lomatium*[1] would be worthwhile.

The first suggestion that there was anything unusual in their habits came while the writer was making illustrations of the various species of *Lomatium* found in the vicinity of Pullman, Washington. In order that this work might be in early progress, the very first umbel of *L. Grayi*, which appeared in March that spring, was eagerly plucked. Nothing unusual was noted until a minute examination was made to determine the exact form of the flowering parts. Then appeared a surprise, for here was an entire umbel, every flower of which lacked styles.

In the hope of explaining this situation, specimens in the herbarium of the State College of Washington were examined. Many of these, collected at various stages of the blooming season, showed perfectly developed styles. Then came the following question: Why should this fresh umbel possess no styles? Was this a common occurrence or merely a rare abnormality? Did other species of *Lomatium* behave in this manner? Would flowers bearing no styles set fruit?

A solution was sought among the various botanical publications, but all monographs and floras failed to give any suggestion that a *Lomatium* blossom ever appeared without styles. Certain statements were noted, however, which attracted attention to another problem. There seemed to be some little contradiction among the different descriptions concerning the presence and condition of the stylopodium in the genus *Lomatium*. The umbel at hand, fresh from the field, showed perfectly developed stylopodia. Yet, several descriptions of the genus stated that these structures were totally wanting. Thus, it seemed advisable to extend the scope of the investigation to cover the status of the stylopodium as well.

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[*] Contribution from the Department of Botany, State College of Washington, No. 19.

[1] Called Cogswellia by the followers of the American Code.

A careful examination of keys and generic descriptions written by outstanding botanists revealed a divergence of opinions. The following authorities declare the stylopodium wanting: Engler and Prantl, Coulter and Rose, Coulter and Nelson, Rydberg, Wooton and Standley, and Henry. Piper and Beattie seem to be inconsistent in their description of this structure. In their generic description they state it to be wanting, while in one key assert it to be flat or none, and in a second key to be flat or obsolete. Jepson states, "stylopodium wanting or not obvious in the fruit." Britton and Brown declare the "stylopodium depressed or none." Small describes the condition as that of a "disk with a depressed stylopodium, or flat." Gray offers a key character, "with depressed stylopodium". The opinion of Bentham and Hooker is found in their description of *Peucedanum,* an old world genus in which they include the American *Lomatium.* Their description, when translated, states that the stylopodium is small and centrally located, or rarely is thick-conical.

With these diverse descriptions in mind, a close observation, extending throughout two spring seasons, was made of living native plants of the species available near Pullman, Washington. These included *L. Gormani, Grayi, triternatum* and *macrocarpum.* Occasional data were obtained in Idaho and Washington of *L. ambiguum, utriculatum* and an unpublished species from the Snake River canyon. During the summer of 1928, another unpublished species, from the mountains of western Washington, was observed throughout a period of five weeks.

The problems concerning these, when definitely formulated, were as follows: (1) To determine the relation between the absence of styles and the setting of fruit, in the available species of *Lomatium.* (2) To determine the time, within the blooming period, during which the styles are produced. (3) To determine throughout the blooming season, the position within the umbel and umbellets, of the flowers which do possess styles. (4) To arrive at some conclusion concerning the status of the stylopodium.

The method of investigation employed rested primarily upon the individual examination of thousands of flowers, with the aid of a binocular microscope. Representative umbels[1] of the various species were collected at intervals of two or three days from the time the first blossoms appeared in March, until well into the fruiting period in June. Two umbellets[2] were chosen at random from each of three positions within the umbel: outer, medial, and inner. All flowers of the selected umbellets were separated from their respective rays and examined, one by one.

As the general investigation proceeded, there were noted within the genus, peculiarities which apparently had received no attention and which none of the above mentioned authorities seemed to discuss. Outstanding among these was the observance of a definite relation of the time of season to the presence or absence of styles. This phase of the study came to be the subject of the greater part of the data collected.

Late in the second season of the study, the tentative findings were related to Mr. Wilhelm N. Suksdorf, who called the writer's attention to the observations, concerning the flowering habits of another species of *Lomatium,* that he had published. These observations were found to be set forth in the original description of *Lomatium flavum,* in "Allegemeine Botanische Zeitschrift", 12: 6, 1906. Mr. Suksdorf has assured the writer that in the original manuscript of this paper, he had given a more complete discussion of the morphological nature of the flowers of this species. However, the editor eliminated much of this material. A translation of Mr. Suksdorf's description reveals that he observed in *L. flavum* the following conditions: The plant produces a primary axis which terminates in a stunted stalk or a single compound[3] staminate umbel. From below the ground surface the stem gives rise to a circle of branches, usually three in number, all of which terminate in solitary umbels, bearing either all staminate flowers or sometimes a mixture of staminate and a few perfect flowers. These three branches produce smaller aerial axillary branches which terminate in solitary umbels, bearing some perfect marginal flowers. In the subsequent axillary branches, the perfect flowers appear numerously, but again, always in the outer rows of umbellets, and here only as the marginal flowers.

The fact that *L. flavum* had been found to possess such characters

[2] The term "umbel" and "umbellet" are used as defined in Asa Gray's "Lessons in Botany," 74-75, 1887.

[3] The term "compound umbel" is used in accordance with the definition given in Gray's "Lessons in Botany," 75, 1887.

added all the more interest to the investigation of the habits of other species of *Lomatium.*

The first seasonal relationship came to be established when it was found that the first umbel, in all the species but one, lacked styles entirely. This behavior was repeated in so many cases that it came to be considered the normal condition.

The second series of umbels which followed, were larger and showed the presence of styles only in the marginal flowers of the outer umbellets, (Fig. 4 and 5). As the season progressed, the pattern of style-bearing flowers in the successively appearing umbels, included not only the marginal flowers of outer umbellets, but also the flowers nearer and nearer the center of both umbellets and umbels. By the end of the blooming season, even the central flowers of some of the umbellets were observed to have styles. However, these were very few, and especially were they rare in the center of the innermost umbellets. Thus, there was noted a constant tendency for the style-bearing flowers to be located in the outer circles of the umbellets and to be most plentiful in the outer circles of the outer umbellets.

A variation of this scheme was found in *L. Gormani*, which presents asymmetrical umbels, (Fig. 3). These were observed to be constructed in such a manner that one ray was much longer than the others. The umbellet of this long ray was the first to exhibit the presence of styles, and as with other species, the style-bearing flowers were located in the outer circle. As the season progressed, the two umbellets whose rays were second in length showed the presence of styles in their outer circles, in addition to those shown in the long-rayed umbellet. Very rarely did the innermost umbellets, which were small and few-flowered, show any presence of styles.

L. Gormani also differed from the species having symmetrical umbels, in that it showed a much higher percentage of flowers with abortive or abbreviated styles. As noted in the tabulated data, (Table 2), these appeared most plentifully during the early part of the blooming season and became comparatively rare during the latter part of the season.

A casual field observation led to a recognition of the fact that among the species of *Lomatium* having symmetrical umbels, the first umbel of each plant withers without setting any fruit. This condition correlated well with the absence of styles in the first appearing umbel. Cross sections of the ovaries of styleless flowers showed that ovules were lacking, a condition which accounted for the inability to set fruit, (Fig. 1 and 2).

In *L. Gormani*, it was noted that in the first umbel, two or three flowers of the long-rayed umbellet, (Fig. 3), would show setting of fruit. This also correlated well with the presence of styles in only a a few flowers of this same umbellet. The remainder of the flowers of the first umbel shriveled, and set no fruit.

Another outstanding feature which showed relation to the season, was the noticeable difference in size of the first umbels and those appearing as the season progressed. Especially in *L. Grayi* and *L. triternatum* was this noted. In the latter, the first umbel was usually from a fifth to an eighth the diameter of those appearing during the late part of the blooming period, (Fig. 4 and 5).

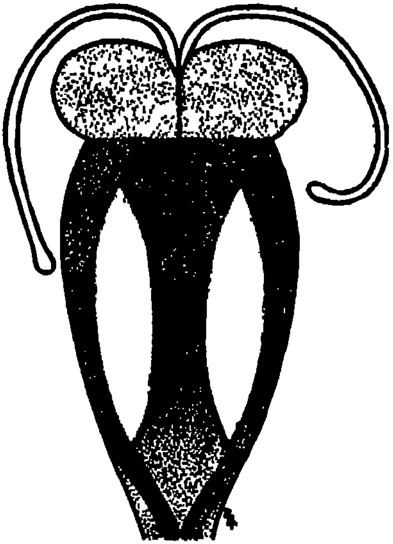

Fig. 1. Lomatium Grayi. Longitudinal section through the ovary of a flower possessing styles. (Enlarged 42 times)

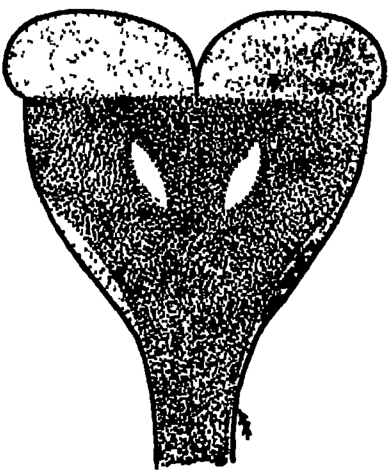

Fig 2. Lomatium Grayi Longitudinal section through the ovary of a flower possessing no styles. (Enlarged 42 times)

Tabulated observations of *L. Grayi* here presented are illustrative of conditions of the species having symmetrical umbels. These data were selected as typical, from a large mass resulting from the examination of the flowers of thirty-eight umbels of living plants.

TABLE 1

LOMATIUM GRAYI COULT. & ROSE

Date Collected	Position of Umbellet	Flowers with style present	Flowers with style abortive	Flowers with style absent
March 30	Outer	0	0	32
	"	0	0	29
	Medium	0	0	31
	"	0	0	31
	Inner	0	0	20
	"	0	0	17
April 16	Outer	0	0	22
	"	0	0	25
	Medium	0	0	21
	"	0	0	20
	Inner	0	0	15
April 20	Outer	9	0	16
	"	9	0	15
	Medium	3	0	18
	"	6	0	15
	Inner	0	0	21
	"	0	0	18
April 25	Outer	13	0	18
	"	13	0	15
	Medium	11	0	15
	"	8	0	21
	Inner	3	0	35
	"	1	0	22
April 30	Outer	14	0	10
	"	10	0	18
	Medium	9	0	12
	"	9	0	11
	Inner	5	0	17
	"	0	0	15
May 2	Outer	18	0	10
	"	23	0	5
	Medium	10	0	13
	"	11	0	17
	Inner	8	0	14
	"	0	0	2

PLATE 1

Fig 3 Lomatium Gormani, showing the asymmetrical umbel Note that the innermost umbellets have set no fruit

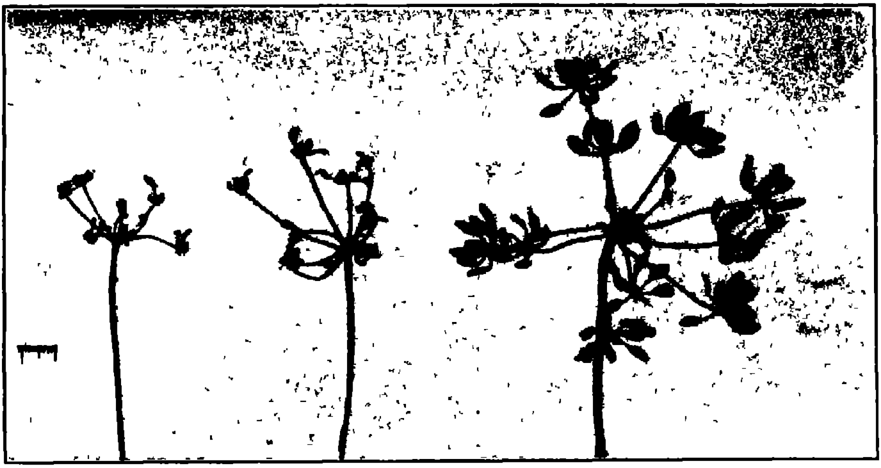

Fig 4 Lomatium Grayi, showing from left to right the increasing amounts of fruit set by the successively appearing umbels

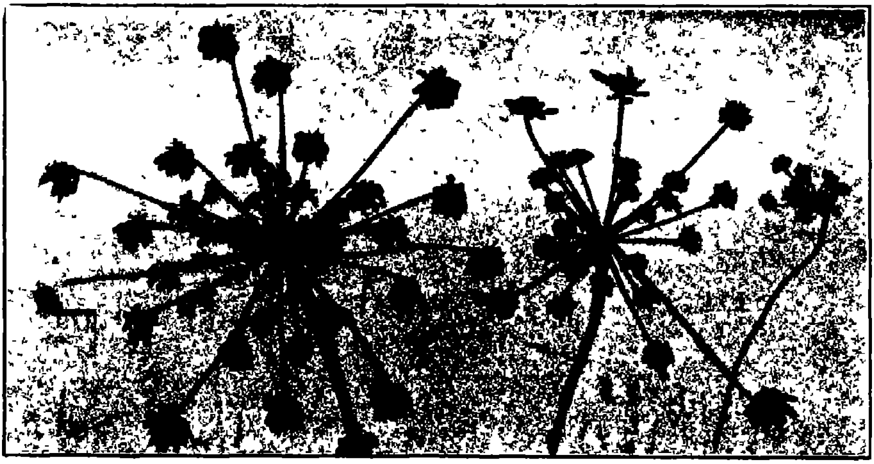

Fig 5 Lomatium triternatum showing from right to left the increasing amounts of fruit set by the successively appearing umbels.

Tabulated observations of another species, *L. Gormani*, are presented to illustrate the condition in a *Lomatium* which possesses an asymmetrical umbel. These data were selected as typical from the results of observations of flowers of forty-six umbels, all of which were from living plants.

TABLE 2

LOMATIUM GORMANI (HOWELL) COULT. & ROSE

Date Collected	Position of Umbellet	Flowers with Style Present	Flowers with Style Abortive	Flowers with Style Absent
March 2	Long-rayed	7	1	2
	Outer	3	1	5
	"	1	1	5
	Medium	0	0	7
	"	0	0	7
	Inner	0	0	4
March 12	Long-rayed	5	3	4
	Outer	1	3	8
	"	2	6	4
	Medium	0	0	8
	"	0	0	6
	"	0	0	9
	Inner	0	0	6
	"	0	0	6
March 14	Long-rayed	2	6	2
	Outer	0	1	7
	"	0	0	6
	Medium	0	0	7
	"	0	0	5
	Inner	0	0	5
	"	0	0	5
	"	0	0	4
March 16	Long-rayed	2	1	2
	Outer	0	0	3
	"	0	0	6
	"	0	0	6
	Medium	0	0	5
	"	0	0	5
	Inner	0	0	4
	"	0	0	2
March 30	Long-rayed	10	0	0

TABLE 2 (CONTINUED)

Date Collected	Position of Umbellet	Flowers with Style Present	Flowers with Style Abortive	Flowers with Style Absent
	Outer	7	0	0
	"	6	0	2
	"	0	1	3
	Medium	0	0	9
	Inner	0	0	5
April 2	Long-rayed	10	1	0
	Outer	7	1	1
	"	4	2	2
	"	2	0	5
	Medium	0	0	6
	"	0	0	7
	Inner	0	0	8
April 8	Long-rayed	10	0	1
	Outer	6	0	7
	"	0	0	8
	"	0	0	6
	Inner	0	0	6
	"	0	0	5
April 11	Long-rayed	13	0	3
	Outer	9	0	5
	"	4	0	8
	Medium	4	1	9
	"	0	0	10
	"	0	0	10
	"	0	0	8
	"	0	0	7
	"	0	0	6
April 16	Long-rayed	11	0	0
	Outer	6	0	3
	"	7	0	4
	"	5	0	7
	Medium	0	0	7
	"	6	0	1
	"	0	0	7
	"	0	0	7
	Inner	0	0	11
April 20	Long-rayed	8	1	1
	Outer	7	0	1
	"	6	0	1

TABLE 2 (CONTINUED)

Date Collected	Position of Umbellet	Flowers with Style Present	Flowers with Style Abortive	Flowers with Style Absent
	"	3	0	3
	"	0	0	5
	Inner	0	0	5
May 2	Long-rayed	10	0	2
	Outer	8	0	3
	"	9	0	3
	"	7	0	3
	"	5	0	3
	Medium	3	0	6
	"	3	0	7
	"	1	0	8
	"	0	0	7
	"	0	0	7
	"	0	0	7
	Inner	0	0	6
	"	0	0	6
	"	0	0	6
	"	0	0	6
	"	0	0	5
	"	0	0	5
	"	0	0	5
	"	0	0	5
May 9	Long-rayed	11	0	1
	Outer	6	0	2
	"	6	0	0
	Inner	1	0	6
May 16[4]	Long-rayed	6	1	0
	Outer	4	0	1
	"	4	0	0
	Inner	0	0	1

While the observations concerning the conditions of styles were being made, a close check was kept, also, of the stylopodium. During the entire study, not a flower was found which lacked a stylopodium. Of the eight species examined, in fresh condition, all possessed stylopodia of the depressed type. There was noted a variation in color, but very little in form. A plausible explanation of the reason that *Lomatiums* had been described as lacking this structure, presented itself when the fresh flowers were compared with the herbarium material of the same species. It was noted that in the dry specimens, the stylopodium had shrunk to such a degree as to be inconspicuous. The fact that many of the workers were obliged to obtain their descriptions from the dry material, accounts, perhaps, for their belief that the stylopodium was lacking.

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[4] The plant collected on this date was growing in the shade and was thus blooming later than most of its kind.

Twenty-seven additional species and two forms of *Lomatium*, from the Herbarium of the State College of Washington, were examined and found in every case to possess stylopodia. These were the following: *L. anomalum, brevifolium, Canbyi, caruifolium, circumdatum, cous, Cusickii, daucifolium, dasycarpum, Donnellii, farinosum, Geyeri, Gormani,* forma *purpureum, laevigatum, macrocarpum,* var. *artemisiarum, Martindalei, montanum, nevadense, oreganum, nudicaule, orientale, Piperi, platycarpum, platyphyllum, robustius, Suksdorfii, tomentosum, vaginatum,* and *Watsoni.*

SUMMARIES

Space does not permit the presentation of a summary of data for all the species observed. The summaries concerning two typical species, *L. Grayi,* and *L. Gormani,* are offered.

Lomatium Grayi Coult. and Rose

1. A depressed stylopodium, pale green in color, and minutely glandular on the surface, was found to be present in every flower examined.

2. The first flowering shoot to appear on each plant, invariably withers and dies without setting fruit.

3. Although the blooming period began March 30, no flowers possessing styles were found until April 20.

4. The first flowers to show the presence of styles are invariably located in the outer rays of the outer umbellets. As the season progresses, styles occur also in flowers of the more centrally located rays of both outer and medial umbellets of the successively formed umbels. Umbels appearing during the latter part of the blooming season may show the presence of styles throughout, although the most centrally located umbellets show by far the least percentage of style-bearing flowers.

5. Only one flower was found which possessed an abortive style.

6. Umbellets which produce flowers with styles usually are surrounded by "leafy" involucels.

7. Twenty-one herbarium specimens of *L. Grayi* were examined. All showed a constant tendency for the earlier flowers to set little or no fruit, while the specimens collected during the latter part of the season showed an abundance of fruit. The fact that the flowers which set the most fruit tend to be located in the outer portion of the outer umbellets, was well illustrated.

LOMATIUM GORMANI (HOWELL) COULT. & ROSE

1. In this species, the umbel is formed in such a manner that one umbellet possesses a much longer ray than any other, thus producing a condition of asymmetry. This long-rayed umbellet is the first to exhibit flowers with styles and also the first to show the setting of fruit.

2. During the earlier part of the blooming season, the appearance of abbreviated or abortive styles was noticeable. By the end of the season they were rarely found in this condition.

3. A depressed stylopodium was found to be present in every flower examined.

4. The presence of numerous glandular pits on the upper surface of the stylopodium, was noted. A thin secretion oozed forth from these pits while the flowers were fresh.

5. A few flowers, located in the inner position of the umbellets, were seen to have the two halves of the stylopodium fused into one. This condition was not common, however.

6. Twelve herbarium specimens were examined. Those collected in the earlier part of the season were noted to have set much less fruit than those of the latter part of the fruiting season.

7. In both the fresh specimens and the herbarium material, there was a well defined tendency for the long-rayed umbellet and one or two of the outer remaining umbellets to set, by far, the greater share of the fruit. Very few cases were found in which the innermost umbellets set any fruit at all. Correlated with this was the observation that very few cases were found in which the flowers of these inner umbellets showed the presence of styles.

GENERAL CONCLUSIONS

1. After examining over five thousand blossoms of *Lomatium* representing the species *Grayi, Gormani, triternatum, ambiguum, macro-*

carpum, *utriculatum*, and two unpublished species, and finding among these living blossoms no case in which the stylopodium was lacking, it seems reasonable to conclude that the flowers of these species do normally possess a stylopodium. It is invariably depressed in form.

2. The size of the successively produced umbels increases as the season advances.

3. Among the species of *Lomatium* bearing symmetrical umbels, the first scape produces no flowers which bear styles. It soon withers without setting fruit. The one species studied which produced asymmetrical umbels, was the only one to show the presence of styles in the blossoms of the first shoot.

4. Cross sections of flowers having no styles, showed that the ovaries were greatly reduced in size and that the ovules were lacking. Thus it is concluded that flowers bearing no styles can set no fruit.

5. Styles may be found in all degrees of completeness from total abortion up to a normal condition. Some species, such as *L. Grayi*, showed a much smaller percentage of abortive styles than others. The abortive condition occurs more frequently during the early part of the season than during the latter.

6. In the symmetrical umbels, the flowers which bear styles and thus set fruit, tend to be located in the outermost part of the outermost umbellets during the earlier part of the season. As the season progresses, such flowers appear, also, in position nearer and nearer the center of both umbellets and umbel. By the latter part of the blooming period, the entire umbel may posses styles and accordingly set fruit, although the flowers of the innermost umbellets usually do not do so.

7. In the asymetrical umbels of *L. Gormani*, the marginal flowers of the long-rayed umbellet are the first to show the presence of styles, and also the first to show the setting of fruit. As the season progresses, the next longest rayed umbellets also produce style-bearing flowers and accordingly set fruit. Very rarely do the innermost umbellets, which are very small and dwarfed, produce style-bearing flowers and thus very seldom set fruit. The long-rayed umbellet and the two next in length of ray, set by the far the greater part of the fruit.

8. Observations of *Leptotaenia multifida* and *L. salmoniflora* show a seasonal floral development strikingly similar to that of *Lomatium*.

The study here presented was carried on in the Botany Department of the State College of Washington, during the springs of 1927 and

1928, under the direction of Dr. Harold St. John, to whom the writer wishes to express her grateful appreciation for valuable suggestions and helpful criticism. She wishes also to express her gratitude to Mr. Wilhelm N. Suksdorf for his assistance in interpreting the description of *Lomatium flavum*.

Department of Botany,
State College of Washington.

PLANTS OF THE HEADWATERS OF THE ST. JOHN RIVER, MAINE

HAROLD ST. JOHN

(Received for publication January 25, 1929)

The headwaters of the St. John River lie in the largest wild and unsettled tract in the state of Maine. Here, as in the western states, the region is divided into square unnamed townships, which are cited by township and range numbers. This tract is over 100 miles in length, yet its flora is practically unknown. As the identity and the distribution of the New England flora is being studied closely, it seems desirable to publish the following list of the plants of this little-known region.

George L. Goodale, later Dr. Goodale, who was for many years a professor of botany at Harvard, was the first botanical explorer of the St. John headwaters. In 1861, the year following his graduation from Amherst, he was made botanist and chemist of the newly organized Scientific Survey of the State of Maine. The personnel of the survey was appointed by the Governor, and by the Secretary of the Board of Agriculture, who was Goodale's father. The directors were Ezekiel Holmes, naturalist, and Charles H. Hitchcock, geologist. In spite of the unsettled conditions resulting from the Civil War, these scientists were instructed to visit several large areas, to investigate their "geology, natural history, agriculture and physical geography, with especial reference to the resources and capabilities of the public domain."[1]

Following these instructions, on August 7, 1861, Dr. E. Holmes, Prof. C. H. Hitchcock, G. L. Goodale, A. S. Packard, Jr., with seven boatmen and hunters, ascended the East Branch of the Penobscot River, then descended the Allagash River. At Long Lake the party divided, and on September 7, Hitchcock, Goodale, and Johnson crossed overland thirteen miles to Seven Islands on the main St. John River. They planned to ascend to its headwaters, but on account of the low stage of the river went only about fifteen miles to T. XI, R. XVI. Turning back they descended the St. John past the mouth of the Allagash, past Fort Kent, to Woodstock, N. B.

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[1] Sixth Ann. Rept. Sec. Me. Board Agri., 94, 1861.

In 1862 a party from the Scientific Survey again visited the region. Prof. Hitchcock, with Goodale, O. White, and two guides started from Moosehead Lake on May 19. The ice had broken up the previous day, and a cold steady rain was falling. They crossed Northwest Carry and ascended the West Branch of the Penobscot. Then they followed up the North Branch, then the Northeast Branch, to its source in Lake Abacotnetic, which they reached on May 23. Carrying across they reached the St. John River, above St. John Pond, where it was no larger than a brook. Even this early in the season the water was too low for easy going on the twenty-three miles down stream to Baker Lake. They pushed on at a good rate, reaching Seven Islands on May 29. This tied in with their previous exploration, so they left the main St. John, carrying over to the Allagash. Ten days sufficed for this trip. The previous one gave Dr. Gooodale even less time in the area. Still, he collected a good many plants, which were deposited at the Portland Society of Natural History. In the published reports of the Scientific Survey, 1861 and 1862, he mentions numerous species. Some have no definite locality, but others are recorded from definite places. Of these a number came from the upper St. John. Other records were published in the Portland Society Catalogue of Maine Plants.[2] Unfortunately in 1866, Goodale's botanical specimens were destroyed in the Portland fire. A very few duplicates had been distributed. These may be consulted in the Gray Herbarium and elsewhere, but for the great majority of Goodale's records, one has no possible means of verification. A few of his records will always remain doubtful. After studying the results of his two years of exploration, Goodale was able to distinguish two natural floral areas within the state.[3] One of these, which he called the "St. John district," was the northern and western portion of Aroostook County, delimited by a line on his map from the Boundary Branch to Grand Falls. He cited fourteen plants as typifying this area, ones thought to be of primarily northwestern distribution. He indicated the coincidence of this area with the occurrence of calciferous slates. Subsequent collectors still find these plants interesting. Their rarity and their calcicolous habitat have drawn many a botanist to northern Aroostook County.

Dr. J. A. Cushman is the only other botanist who is known to have collected extensively within the area being considered. Between the eleventh and the fourteenth of September, 1907, he collected 150 specimens near the Little Black River Rapids. In this number are nineteen species not found by Dr. Goodale or the writer. The specimens are deposited in the Herbarium of the Boston Society of Natural History.

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[2] Goodale, G. L., and Blake, Joseph, The Portland Catalogue of Maine Plants, Proc. Portland Soc. Nat. Hist. 1: 1868.

[3] Seventh Ann. Rept. Agri. & Geol. Me., 2nd ser., 125-127, 1862.

With the aid from a Sheldon Travelling Fellowship, of Harvard University, as well as an assistantship, and the loan of collecting material from the Canadian Geological Survey, the writer explored and studied the flora of the headwaters of the main St. John River. Fortunately it was possible to arrange to have as companion and assistant Dr. George E. Nichols of Yale. With two guides and two twenty-foot canoes' the start was made from Kineo on Moosehead Lake, July 5, 1917. By the use of an auto truck the outfit was portaged over a new lumber road to Pittston Farms, in the town of Pittston, Somerset County, Maine, thus saving the Northwest Carry and three days of hard paddling through the back waters on the West Branch of the Penobscot. By travelling steadily, Abacotnetic Bog was reached on July 8. The next day the three-mile carry was made to St. John Pond. On July 15 camp was moved down to Baker Lake. Only July 20, the lake was left behind, and the long trip down the St. John River was made with more frequent but shorter stops. Fort Kent, the destination of the 250-mile canoe trip, was reached on July 29. The collections totaled 1604 sheets, including 352 species, while 114 others were observed, and 2428 notes upon plant distribution were made. The specimens were divided into five sets. These may be consulted in the Herbarium of the New England Botanical Club, the Eaton Herbarium of Yale University, the Canadian National Herbarium, the United States National Herbarium, and the New York Botanical Garden.

An additional result of this trip was the improvement of the method of pressing plants by the use of double-faced ventilators and artificial heat. This has already been published.[4] It was realized that on this long, hard canoe trip the botanical outfit must be reduced to a minimum. The ordinary method of using driers and daily spreading them in the sun to have its heat drive off the moisture did not seem usable. They were bulky and heavy, and in a region of continuous boggy forest and frequent rains, neither dry ground nor sun could be depended

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[4] Nichols, G. E., and St. John, H., Pressing Plants with Double-Faced Corrugated Paper Boards, Rhodora 20: 158-160, 1918.

PLATE 2

Upland woods of sugar maple near Green Mt

Shallow pond and black spruce at Abacotnetic Bog

Shingle ,beach near Baker Lake

upon. By necessity the new method was developed; only a few driers were used in the first pressure. In the second pressure driers were eliminated and the plants alternated between double-faced ventilators. This second press was suspended from a tripod over an open camp fire. It needed but little attention and in five or six hours turned out completely dry specimens, nicely preserving the natural color. Further details can be found in the article just referred to.

Nearly twelve years have passed since the writer made this botanical exploration. It is for many reasons undesirable to allow such an interval between a trip and the publication of its results. Yet, at times, delays seem unavoidable, and in this case they were caused by the World War and by the removal of the writer to another state. In order to bring this list up to date with the important recent monographic revisions, it has been necessary to ask the assistance of a number of botanists. Mr. S. N. F. Sanford has kindly verified several of Dr. Cushman's plants. The writer is under especial obligations to Prof. M. L. Fernald of the Gray Herbarium for assistance in organizing the trip, for help in the determination of critical specimens, for recent verifications, and for many constructive suggestions.

From the region of Fort Kent, St. Francis, and the Allagash River, many botanical collections have been made. Further upstream the flora is quite unknown. Hence this list of plants will include the valley of the main St. John River from just above the mouth of the Allagash River up to the headwaters. Also all known records are included for the North Branch of the West Branch of the Penobscot River from Pittston to T. IV, R. XVII, and for the North East Branch of the North Branch of the West Branch of the Penobscot to its source in Lake Abacotnetic. The records for the drainage of the Penobscot are less complete than those for the St. John, since both Goodale's party and the writer's party hurried up this shallow stream for fear of being stranded by the fall of the water. Field notes were kept, recording every plant seen and recognized, every day of the trip. These, together with the specimens collected, give with considerable detail the range of the members of the flora. In previous studies of plant distribution this great area on the western border of Maine has always appeared a blank. It seems wise, therefore, to print in a condensed form all of these records. Particularly so, since the region through its inaccessibility, the great difficulty of travel, and the large expense involved, is not likely to be soon revisited by other botanists.

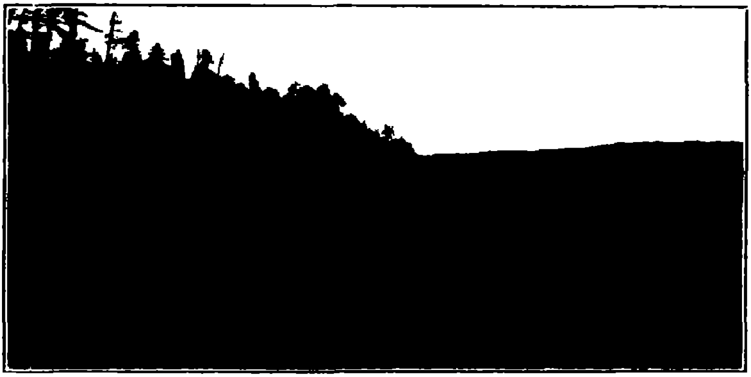
The physiography and geology of the region will be described briefly. The area is a plateau of moderate elevation. The height of land on the St. John Carry between St. John Pond and Lake Abacotnetic is 1694 feet. The slope from this is very gradual to 600 feet at the mouth of the Allagash River. Occasionally ridges rise above the general level, but never more than a few hundred feet. No mountains are to be seen.

The country rock shows several formations. On the North Branch of the Penobscot, massive clay slate ledges cross the river, forming Leadbetter Falls in T. IV, R. XVIII. Green Mountain on the western river bank rises some 500 feet above the river, showing exposures of an argillaceous rock. On the North East Branch in T. V, R. XVIII, ledges of mica schist are observed. Except for a few small areas, this mica schist is the country rock northward for many miles. Along Woboostoock Stream in T. VI, R. XVI, clay slates are again met with. From the mouth of the South West Branch of the St. John, limy gravel beaches were met frequently to the northern boundary. These were mostly resorted glacial gravels and not derived from the country rock. At the Little Black River Rapids, in T. XVII, R. XI, the rock resembled a talcose schist. Limy slate ledges outcrop above Seven Islands and at the Big Black River Rapids. Except for these few ledges along the rivers, the rocks are not exposed. They are deeply covered with glacial drift. This is heterogeneous, but largely of acid crystalline rocks. However, from half way down the St. John to Fort Kent the river gravels contain many limy boulders, and the beaches support a noticeable calcicole vegetation, including *Tofieldia glutinosa, Allium Schoenoprasum,* var. *sibiricum, Equisetum variegatum, Astragalus alpinus,* var. *Brunetianus, Potentilla fruticosa,* and *Hedysarum boreale.* Greenish serpentine boulders were noticed, but they had no appreciable effect on the vegetation.

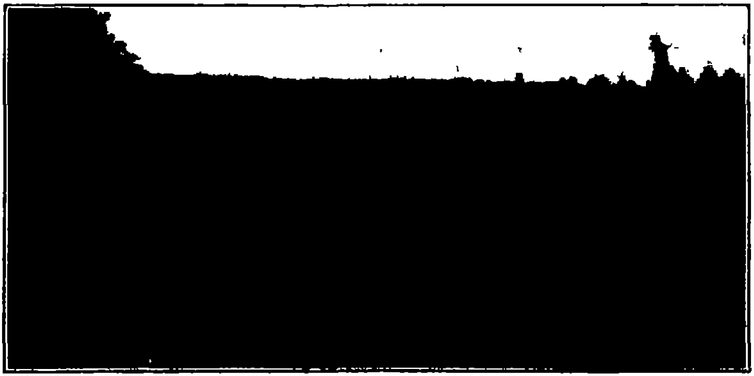
The few ridges that rise above the general level, have on their upper slopes good stands of hardwood trees, such as sugar maple, mountain maple, and beech. The great expanse of the plateau is boggy and densely covered with an evergreen forest. The primeval stand probably contained much white pine, but now only a few of these old trees are left. From Dr. Goodale's statements we know that this whole area had been lumbered well before 1861. Because of the dampness of the region, fires have not been serious. Small burnt areas occur here and there, but the only large area burnt, and reburnt, is below the mouth

Plate 3

Station for the shrubby cinquefoil on the St John River, just above the mouth of the Northwest Branch



The St John River below Seven Islands showing the big river flowing beneath the high banks



The Big Black River Rapids on the St John River, showing Spartina Michauxiana along the bank.

of the North West Branch of the St. John River. Elsewhere second-growth woods have sprung up vigorously, making dense stands of mixed spruce and fir. On the average, every acre of this section is lumbered every thirty years. From a distance the forest looks green and attractive. On a close inspection it is found, however, that the forest floor is covered with slashings, and that the vegetation is in a sadly mutilated condition. The undershrubs and the herbaceous perennials are scarce, and usually stunted or malformed individuals. Undisturbed woodlands were seen only on the slopes of some of the hardwood ridges; and on Green Mountain. The slopes of the latter were too steep to lumber. Here the rocks were covered by a thick mat of mosses, and festooned with *Polystichum Braunii*, var. *Purshii*. Towering above were primeval trees such as balsam poplars four feet in diameter and ninety feet high. Undisturbed natural conditions were also found in the wet meadows and on the shelving shores of the river.

Near Pittston on the Penobscot, and from Seven Islands north on the St. John, alluvial islands and intervales were encountered, where fine big American elms shaded the waters.

Several lakes have been mentioned, but they are all in reality nothing but small ponds. Other branches and other rivers, heading not far away, spring from great chains of lakes. These store the waters, saving plenty for the summer months. Thus, th
northern Maine a paradise for the canoist and camper. Lake
been said, are conspicuously absent in the area studied.

The rivers are narrow, shallow gutters on the gently sloping plateau. Within a few hours after the rain, most of the water has rushed violently down stream, and the headwaters have dwindled to a trickle of water between the rounded boulders of the stream bed. This is the factor that makes the region so very inaccessible. Goodale, in 1861, it will be remembered, was unable to ascend the main St. John more than fifteen miles above Seven Islands. In 1862 he started in May, the day after the ice moved out, and even so, had trouble navigating the Woboostoock Stream because of low water.

May and June, 1917, were exceptionally rainy months in New England. According to local testimony at Kineo, it rained steadily from May 1 until July 3. The start was made on July 5. During the night of the 6th, the river fell six inches, a serious matter. Nichols and the writer had walked the banks most of the way in order to botanize, but from Green Mountain on, it was necessary to walk so as to lighten the canoes. The river became so shallow that one could wade it at will. On the last day up stream, even the guides had to wade and drag the canoes. At St. John Pond the guides constructed a dam with logs, birch bark, and stones across the outlet. In five days this caused the water in the Pond, which is two and a half miles long, to rise a foot. The night before moving down stream, the dam was breached. There was but one noticeable stretch of still water in the twenty-three miles. The gradient was so steep that the river, or Woboostoock Stream as it is called here, pitched down, down, so steeply that the guides continually snubbed with their eleven-foot, steel-shod poles to check the speed of the canoes and round successfully the sharp bends of the river. Even so, the canoes out-ran the artificial flood, and for miles scraped the rocks in the shallow water. From Baker Lake down the Woolastaquaquam Stream and the River St. John there was plenty of water for canoeing

KEY TO ABBREVIATIONS

For the sake of brevity, each locality from which there are species cited, is represented by a letter or number. These appear in the following list and map. The abbreviation P. means that the plant was observed by H. St. John and G. E. Nichols at locality P., which is Pittston. P no. 2,123, means that the plant was collected at Pittston by H. St. John and G. E. Nichols, and that the specimens of it were distributed under the collector's number 2,123. The abbreviation 11 no. C 2,003, means that the plant was collected by J. A. Cushman at locality 11, or the Little Black River Rapids, and that his specimens will be found with the number 2,003. The names of adventive species are printed in italics.

NORTH BRANCH OF THE WEST BRANCH OF THE PENOBSCOT RIVER

P. = Pittston, Somerset County, Maine.
2 = Township IV, Range XVIII, Somerset Co.

NORTH EAST BRANCH OF THE NORTH BRANCH OF THE WEST BRANCH OF THE PENOBSCOT RIVER

3. = From Camp 2 to 3, T. IV and V, R. XVIII, Somerset Co.
4. = From Camp 3 to 4, T. V, R. XVIII; T. V and VI, R. XVII, Somerset Co.

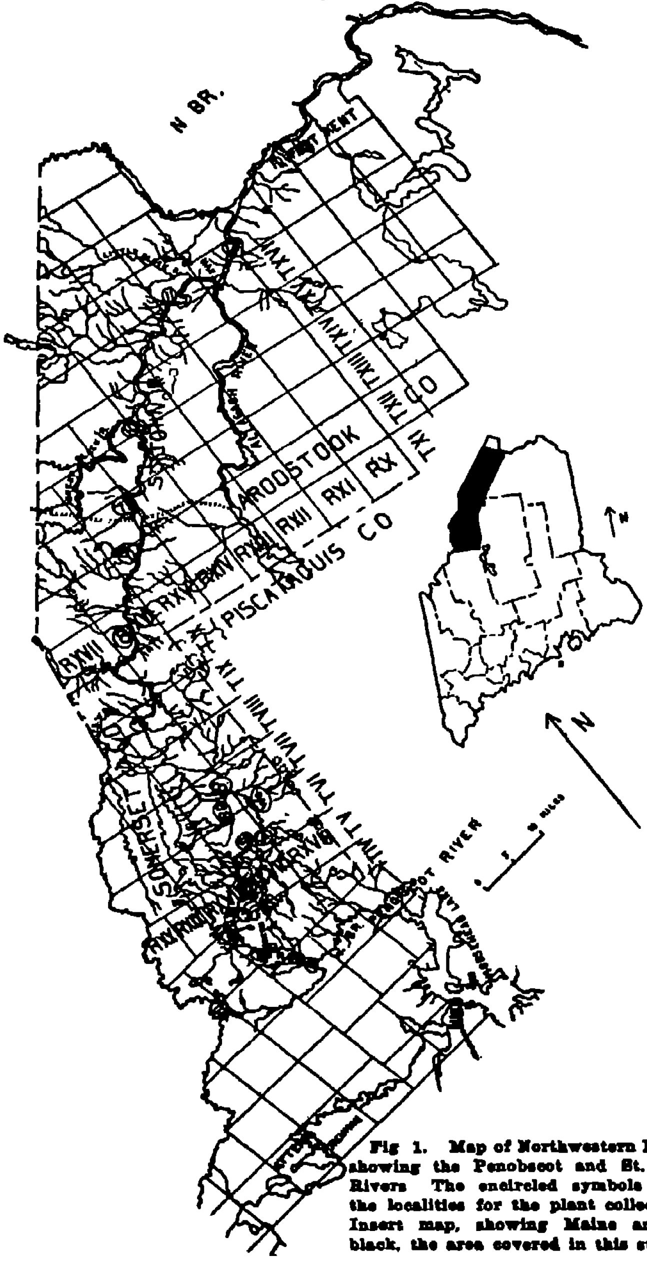


Fig. 1. Map of Northwestern Maine, showing the Penobscot and St. John Rivers. The encircled symbols mark the localities for the plant collections. Insert map, showing Maine and, in black, the area covered in this study.

MAIN OR BAKER BRANCH OF THE ST. JOHN RIVER

St. = St. John Pond, T. V and VI, R. XVII, Somerset Co.

W. = Woboostoock Stream, T. VI, R. XVII; and T. VI, R. XVI, Somerset Co.

Wo. = Woboostoock Stream, T. VII, R. XVI; and T. VII, R. XVII, Somerset Co.

B. = Baker Lake, T. VII, R. XVII, Somerset Co.

BB. = Baker Brook and Baker Bog, T. VI and VII, R. XVII, Somerset Co.

7. = Woolastaquaquam Stream from Baker Lake to Camp 7, T. VII, VIII, and IX, R. XVII, Somerset Co.

RIVER ST. JOHN

8. = From Camp 7 to 8, T. IX, X, and XI, R. XVII; T. X, and XI, R. XVI, Somerset and Aroostook Counties.

9. = From Camp 8 to 9, T. XI, and XII, R. XVI; T. XII, and XIII, R. XV, Aroostook Co.

7I. = Seven Islands, T. XIII, R. XV, Aroostook Co.

10. = From Camp 7I to the Big Black River Rapids, T. XIII, and XIV, R. XIV; T. XIV, and XV, R. XIII, Aroostook Co

11. = From Camp 10 to the Little Black River Rapids, T. XV, and XVI, R. XIII; T. XVI, R. XII; and T. XVI, and XVII, R. XI, Aroostook Co.

12. = From Camp 11 to the mouth of the Allagash River, T. XVI, and XVII, R. XI; T. XVI, and XVII, R. X, Aroostook Co.

LIST OF VASCULAR PLANTS

POLYPODIACEAE

Adiantum pedatum L. P no. 2,056.

Asplenium viride Huds. 2 no. 2,055.

Athyrium angustum (Willd) Presl., var. laurentianum Butters. W no. 2,067; 10 no. 2,066. Field notes credit this or the following variety to 2; 3; 4; B; St; 7; 8; 7I; 11; 12.

A. angustum, var. rubellum (Gilbert) Butters. 10 no. 2,065.

Cystopteris bulbifera (L.) Bernh. Green Mt. in 2 no. 2,068.

C. fragilis (L.) Bernh. Green Mt. in 2 no. 2,069.

Dennstædtia punctilobula (Michx.) Moore. St no. 2,071.

Onoclea sensibilis L. P; 2; 3; 4; St; W; Wo; B; BB; 7; 8; 9; 7I no. 2,072; 10; 11; 12.

O. sensibilis, forma obtusilobata (Schkuhr) Gilbert. P; 2; 3; W; 8; 71.

Polypodium virginianum L. 2; 10 no. 2,054.

Polystichum Braunii (Spenner) Fée, var. Purshii Fernald. 2 no. 2,064; St.

Pteretis nodulosa (Michx.) Nieuwl. P; St; W; BB; 7; 8; 7I no. 2,073; 10; 11; 12.

Pteridium latiusculum (Desv.) Maxon. 2; 3; 4; St; W; BB; 7; 8; 9; 7I; 10; 11; 12.

Thelypteris cristata (L.) Nieuwl. St no. 2,061; B; BB; 10.

T. Dryopteris (L.) Slosson. P; 2; 3; 4; St no. 2,058; W; Wo; B; BB; 7; 8; 9; 7I; 10; 11; 12.

T. marginalis (L.) Nieuwl. Green Mt. in 2 no. 2,060.

T. noveboracensis (L.) Nieuwl. P; St; BB; 7; 8; 10; 12 no. 2,059.

T. palustris Schott. St; B

T. Phegopteris (L.) Slosson. P, 2; 3; 4; St no. 2,057; W; Wo; B; BB; 7; 8; 9; 10; 11 no. C 2,116; 12.

T. spinulosa (O. F. Muell.) Nieuwl., var. intermedia (Muhl.) Nieuwl. 3, 4; St nos. 2,062 & 2,063, W; B, BB, 7; 8, 7I; 10; 11 no. C 2,118; 12.

Woodsia ilvensis (L.) R. Br. 10 no. 2,070.

OSMUNDACEAE

Osmunda cinnamomea L. P; 3; 4; St no. 2,075; W; B; BB; 7; 8; 9; 7I; 10; 11; 12.

O. Claytoniana L. 3; 4; St; W; Wo; B; BB; 7; 8; 7I; 10; 11; 12 no. 2,076.

O. regalis L., var. spectabilis (Willd.) Gray. St no. 2,074; W; B; BB; 7, 8; 9; 10; 11.

OPHIOGLOSSACEAE

Botrychium virginianum (L.) Sw. 2 no. 2,078; 3 no. 2,079; B; 8 nos. 2,077 & 2,080; 10.

B. virginianum, var. europaeum Angstr. 12 no. C 2,173. Determined by S. N. F. Sanford.

EQUISETACEAE

Equisetum arvense L. P; 2; 3; 4; St; 10 no. 2,081.

E. arvense, forma decumbens (Meyer) Klinge. B no. 2,082.

E. limosum L. 4; St no. 2,085; Wo; B; 7; 8; 9; 7I no. 2,084; 10; 11; 12.

E. scirpoides Michx. 10 no. 2,087.

E. sylvaticum L., var. pauciramosum Milde. P; 2; 3; 4; St no. 2,083; W; Wo; B; BB; 7; 8; 9; 7I; 10; 11; 12.

E. variegatum Schleich. 8 no. 2,086; 10.

LYCOPODIACEAE

Lycopodium annotinum L. 2; 3; 4; St no. 2,092; W; B; BB; 8; 9; 7I; 10; 12.

L. clavatum L. P; 2; 3; 4; St no. 2,092; W; B; BB; 7; 8; 9; 7I; 10; 12.

L. inundatum L. 9 no. 2,091.

L. lucidulum Michx. 2; 3; 4, St no. 2,090; W; B; BB; 11; 12.

L. obscurum L. P; 2; 4; St no 2,094; B; BB; 7; 8; 7I; 10.

L. obscurum, var. dendroideum (Michx.) D. C. Eaton. 8 no. 2,095; 9; 11; 12.

L. sabinaefolium Willd. 8 no. 2,096.

SELAGINELLACEAE

Selaginella selaginoides (L.) Link. 10 no. 2,097.

ISOETACEAE

Isoetes macrospora Dur., f. hieroglyphica (A. A. Eaton) Pfeiffer. St no. 2,088; 7I no. 2,089.

TAXACEAE

Taxus canadensis Marsh 12 no. 2,098.

PINACEAE

Abies balsamea (L.) Mill. P; 2; 3; 4; St; W; Wo; B; BB; 7; 8; 7I; 10; 11; 12.

Larix laricina (Du Roi) Koch. St; Wo; BB no. 2,101; 7; 8; 9; 7I; 10; 11; 12.

Picea canadensis (Mill.) BSP. P; 2; 3; 4; St; W; Wo; B; BB; 7; 8; 9; 7I; 10; 11; 12.

P. mariana (Mill.) BSP. St; BB; 7; 8 no. 2,102; 9; 11.

P. rubra (Du Roi) Dietr. P; 2; 3; 4; St; W; Wo; B; BB; 7; 8; 9; 7I; 10; 11; 12.

Pinus resinosa Ait. 8 no. 2,100.

P. Strobus L. P; 2; 3; 4; St; W; Wo no. 2,099; B; BB; 7; 8; 9; 7I; 10; 11; 12.

Thuja occidentalis L. P; 2; 3; 4; St no. 2,103; W; Wo; B; BB; 7; 8;

9; 7I; 10; 11; 12.
Tsuga canadensis (L.) Carr. P; 2.

NAJADACEAE

Potamogeton alpinus Balbis. 7I no. 2,104.
P. amplifolius Tuckerm. St no. 2,108.
P. bupleuroides Fernald. B no. 2,105; 11.
P. epihydrus Raf. St; 10.
P. gramineus L., var. graminifolius Fries. St no. 2,109; B; 7; 8, 7I.
P. natans L. B no. 2,106.
P. praelongus Wulf. St no. 2,107.

JUNCAGINACEAE

Scheuchzeria palustris L., var. americana Fernald. BB no. 2,110.

ALISMACEAE

Sagittaria graminea Michx. St no 2,113; 7I no. 2,112; 10; 11.
S. latifolia Willd., f. hastata (Pursh) Robins. 7I no. 2,111; 11 no. C 2,102.

GRAMINEAE

Agropyron caninum (L) Beauv., f. pubescens (Scribn. & Sm.) Pease & Moore. 8 no. 2,145.
A. repens (L.) Beauv. P; 2; 3; BB; 8; 9; 7I, 10; 11; 12.
Agrostis alba L. 4; 11 no. C 2,139; 12.
A. alba L., var. maritima (Lam.) G. F. W. Mey. 7I no 2,127.
A. hyemalis (Walt.) BSP. 7I no. 2,126; 11 no. C 2,081.
Anthoxanthum odoratum L. 4; 8.
Bromus ciliatus L. 7I no. 2,144; 11 no C 2,129; 12
Calamagrostis canadensis (Michx) Nutt. B; BB; 7; 8; 9; 7I; 10; 11; 12 no. 2,128.
Cinna latifolia (Trev.) Griseb. P; 2; 3; 4; St; W; Wo; B; BB; 7; 8, 9; 7I; 10; 12.
Danthonia spicata (L.) Beauv. 3; 8 no. 2,134; 9; 7I; 10; 11; 12.
Deschampsia cespitosa (L.) Beauv., var. glauca (Hartm.) Lindm. f. 8 no. 2,133; 9; 11 no. C 2,087; 12.
D. flexuosa (L.) Trin. 10 no. 2,132.
Elymus virginicus L. 11 no. C 2,133.
Festuca *elatior* L. introduced at B, fide Goodale p. 338 (1862).
F. rubra L. BB; 7; 8; 9; 7I; 10.

Glyceria canadensis (Michx.) Trin. B; 12 no. 2,143.

G. grandis Wats. 11 no. 2,142.

G. nervata (Willd.) Trin. 7I no. 2,140.

G. nervata (Willd.) Trin., var. stricta Scribn. 8 no. 2,141.

Hierochloe odorata (L.) Wahlenb., var. fragrans (Willd.) Richter. 9 no. 2,119; 11.

Milium effusum, L. 3; abundant along the Penobscot; St no. 2,120.

Muhlenbergia racemosa (Michx.) BSP. 11 no. C 2,138.

Oryzopsis asperifolia Michx. 2 no. 2,121; 3; St; W; 7 no. 2,122; 8; 9; 7I.

O. canadensis (Poir.) Torr. 8 no. 2,123.

Panicum boreale Nash. 7 no. 2,114; 8; 9; 7I.

P. huachucae Ashe. 8 no. 2,115; 9; 7I.

P. linearifolium Scribn. 9 no. 2,116.

P. Lindheimeri Nash, var. septentrionale Fernald. 11 Little Black River, *E. F. Williams* & *J. F. Collins*.

Phalaris arundinacea L. B; 8 no. 2,118; 7I no. 2,117; 10; 12.

Phleum alpinum L. 11 no. 2,125.

P. *pratense* L. P; 3; 4; St; W; B; BB; 7; 8 no. 2,124; 9; 7I; 10; 12.

Phragmites communis Trin. St no. 2,136; 7I *M. F. Keep*

Poa alsodes Gray. 3 *St. John & Nichols* without number.

P. *annua* L. P; 3; St.

P. palustris L. 3; 8 no. 2,137; 11 no. C 2,151.

P. pratensis L. P; 3; St; Wo, B; BB; 7; 8; 9; 7I; 11; 12.

P. saltuensis Fernald & Wiegand. P no. 2,138.

P. saltuensis, var. microlepis Fernald & Wiegand. BB no. 2,139.

Schizachne purpurascens (Torr.) Swallen. 2 no. 2,147; 3; St no. 2,146; W; B; BB; 7; 8 no. 2,148.

Setaria lutescens (Weigel) Hubb. 11 no. C 2,050a.

Spartina Michauxiana Hitchc. 10 no. 2,135; 11 no C 2,156; 12.

Trisetum spicatum (L.) Richter, var. molle (Michx.) St. John[5] 2 no. 2,131; 8 no. 2,130; 9 no. 2,129.

[5] Trisetum spicatum (L.) Richter, var. molle (Michx.) n. comb. Avena mollis Michx., Fl. Bor. Am. 1. 72, 1803, Trisetum spicatum molle (Michx.) Piper, Contr. U S. Nat. Hb. 11· 125, 1906. See Rhodora 18: 197, 1916 It seems necessary to make this combination, since it was not done legally by Piper, who made it a trinomial, or by Fernald, who did not make the combination himself. He merely attributed it to Piper, who, as stated, made it a trinomial without indication of the rank of the subdivision of the species.

CYPERACEAE

Carex aquatilis Wahlenb. BB no. 2,165; B; 8; 9; 7I; 11.
C. arctata Boott. P; 2; 3; St no. 2,189; W; BB; 11 no. 2,188.
C. atrata L., var. ovata (Rudge) Boott. 2 no. 2,172.
C. aurea Nutt. 8 no. 2,168; 10; 11.
C. brunnescens Poir. P; 2; St no. 2,162; W; B; BB; 8; 10.
C. canescens L., var. disjuncta Fernald. 4; St no. 2,161; W; B; BB; 7; 8; 10; 11; 12.
C. castanea Wahlenb. 2 no. 2,187; 8 no. 2,186; 9; 10.
C. communis Bailey. St no. 2,177.
C. conoidea Schkuhr. 8 no. 2,183.
C. crinita Lam. 2; 3; 4; St no. 2,164; W; B; 8; 9; 7I; 10; 11; 12.
C. crinita Lam., var. simulans Fernald. 11 no. C 2,185.
C. cryptolepis Mack. 11 no. C 2,147.
C. debilis Michx., var. Rudgei Bailey. St no. 2,190.
C. deflexa Hornem. St no. 2,176.
C. echinata Murr. 4; St no. 2,160; B; BB; 8; 9; 10; 11; 12.
C. flava L. 2; 3; W; 7; 8 no. 2,184; 9; 7I; 10; 11; 12.
C. gracillima Schwein. 8 no. 2,174.
C. intumescens Rudge. P; 2; 3; 4; St no. 2,193; W; Wo; B; BB; 7; 8; 9; 7I; 10; 11; 12.
C. laxiflora Lam. P; 2.
C. lenticularis Michx. B; 7I no. 2,166.
C. leptalea Wahlenb. 2; St no. 2,171; 8 no. 2,170.
C. leptonervia Fernald. St no. 2,182.
C. limosa L. BB no. 2,180.
C. Oederi Retz, var. pumila (Coss. & Germ.) Fern. 10 no. 2,185; 11.
C. oligosperma Michx. BB no. 2,191.
C. pallescens L. St no. 2,178.
C. pauciflora Lightf. BB no. 2,169.
C. paupercula Michx., var. pallens Fernald. BB no. 2,179; B.
C. pedunculata Muhl. 8 no. 2,181.
C. polygama Schkuhr. 8 no. 2,173.
C. projecta Mack. 7I no. 2,159; 11 no. C 2,187.
C. retrorsa Schwein. 7I no. 2,192; 11 no. C 2,150; 12.
C. scirpoidea Michx. 9 no. 2,175.
C. stipata Muhl. 2; 3; 4; St no. 2,163; BB; 7; 8; 10; 11; 12.
C. stricta Lam. 4; probably as common as the variety.

C. stricta Lam., var. decora Bailey. 3; 4; St; W; Wo; B; 7; 8; 7I no. 2,167; 10.

C. torta Boott. 3 *St. John & Nichols* without number.

C. vesicaria L. 2; 3; 4; B; 7; 8; 9; 7I; 10; 11; 12 no. 2,194.

Dulichium arundinaceum (L.) Britton. St; B; 7I no. 2,149; 10; 11; 12.

Eleocharis acicularis (L.) R. & S. 3; 4; St; W; B; 7; 8; 9; 7I no. 2,150; 11; 12.

E. palustris (L.) R. & S., var. major Sonder. St no. 2,151.

Eriophorum angustifolium Roth. 10 no. 2,157.

E. spissum Fernald BB no. 2,156.

E. virginicum L. BB no. 2,158; 11 no C 2,088; 12.

Mariscus mariscoides (Muhl) Kuntze. 11 no. C 2,204.

Rynchospora capitellata (Michx.) Vahl., var. minor (Britt.) Blake. 11 no. C 2,143.

Scirpus americanus Pers. B.

S. atrocinctus Fernald. 4, St; B; BB; 11 no. C 2,157.

S. cespitosus L., var. delicatulus Fernald. 9 no. 2,154; 10; 11.

S. Clintonii Gray. 2 no. 2,152; 7 no. 2,153.

S. rubrotinctus Fernald. 3; 4; St; Wo; BB; 8; 7I; 10 no. 2,155; 11; 12.

ARACEAE

Arisaema Stewardsonii Britton. 2 no. 2,195; 3; St; BB no. 2,196; 7I; 11.

ERIOCAULACEAE

Eriocaulon septangulare With. St.

JUNCACEAE

Juncus articulatus L. 11 no C 2,122.

J. articulatus L., var. obtusatus Engelm. 11 no. C 2,148.

J. balticus Willd., var. littoralis Engelm. 10 no. 2,199.

J. canadensis J. Gay. 11 no. C 2,148a.

J. Dudleyi Wiegand. 10 no. 2,198.

J. effusus L., var. Pylaei (Laharpe) Fernald & Wiegand. BB.

J. filiformis L. BB; B no. 2,201 & 2,202; 7I no. 2,200; 12.

J. tenuis Willd. 4; 7I no. 2,197; 11.

Luzula campestris (L.) DC., var. multiflora (Ehrh.) Celak. P; 2 no. 2,205; 3; W; BB no 2,207; 7; 8 no. 2,208; 9; 10; 11 no. C 2,172; 12.

L. parviflora (Ehrh.) Desv. 2 no. 2,205; 8 no. 2,204.
L. saltuensis Fernald. P; 3; 8 no. 2,203; 10; 11.

LILIACEAE

Allium Schoenoprasum L., var. sibiricum (L.) Hartm. 2 no. 2,214; 8 no. 2,215; 9; 7I; 10; 11 no. C 2,140; 12. Reported "on St. John" as the species by Goodale, p. 128 (1861).
Clintonia borealis (Ait.) Raf. P; 2 no. 2,218; 3; 4; St; W no. 2,217; B; BB; 7; 8; 7I; 10; 11 no. C 2,077; 12.
Lilium canadense L. 4; 7I no. 2,216; 10; 11; 12.
Maianthemum canadense Desf. P; 2; 3; 4; St; W; Wo; B; BB; 7; 8; 9; 7I no. 2,221; 10; 11 no. C 2,175; 12.
Medeola virginiana L. St no. 2,224; 11 no. C 2,196; 12.
Oakesia sessilifolia (L.) Wats. 2 no. 2,212; 8 no. 2,213; 9 no. 2,211; 7I; 10.
Polygonatum biflorum (Walt.) Ell. St no. 2,223.
Smilacina stellata (L.) Desf. 2; 8 no. 2,219.
S. trifolia (L.) Desf. 4; St; BB no. 2,220.
Smilax herbacea L. 7 no. 2,228; 8; 9; 10; 11 no. 2,229 and C 2,136.
Streptopus amplexifolius (L.) DC. 2; 3; 4; St; W; 10; 11 no. C 2,177.
S. roseus Michx. 2; 3; 4; St; W; B no. 2,222; BB; 7I; 10; 11 no. C 2,174; 12.
Tofieldia glutinosa (Michx.) Pers. 2; 8 no. 2,209; 9; 7I; 10; 11 nos. C 2,070 & C 2,097; 12. Recorded by Goodale on wet river ledges pp 128 and 366 (1861); 126 and 339 (1862).
Trillium erectum L. 2 no. 2,226; B no. 2,225; 7I.
T. undulatum Willd. St; W; B; BB; 7; 7I; 10; 11 no. C 2,176; 12.
Veratum viride Ait. P; 2; 3; 4; St; W; Wo; BB; 7; 8; 9; 7I; 10; 11; 12 no. 2,210.

IRIDACEAE

Iris versicolor L. P; 2; 3; 4; St; W; Wo; B; BB; 7; 8 no. 2,230; 9; 7I; 10; 11; 12.
Sisyrinchium angustifolium Mill. P; 3; 4; St; BB; 8 no. 2,231; 9; 7I; 10; 11; 12.

ORCHIDACEAE

Calypso bulbosa (L.) Oakes. 2 at Green Mt., fide Goodale p. 336 (1862).

Corallorrhiza maculata Raf. 12.
C. trifida Chatelain. 4 no. 2,244; St no. 2,243; BB no. 2,245.
Epipactis repens (L.) Crantz, var. ophioides (Fernald) Eaton. St no. 2,239; 7I; 11; 12.
E. tesselata (Lodd.) A. A. Eaton. 11 no. C 2,075; 12 no. 2,240.
Habenaria dilatata (Pursh) Gray. P; 3; 8 no. 2,235; 9; 7I; 10; 11 no. C 2,125; 12.
H. fimbriata (Ait.) R. Br. 7I no. 2,236; 10; 12.
H. obtusata (Pursh) Richards. 3; 4; St; W; B no. 2,234; BB.
H. orbiculata (Pursh) Torr. 12 no. 2,233.
H. psycodes (L.) Sw. 7 no. 2,237; 8; 9; 11; 12.
H. viridis (L.) R. Br., var. bracteata (Muhl.) Gray. 12 no. 2,232.
Listera convallarioides (Sw.) Torr. St no. 2,241.
L. cordata (L.) R. Br. 4; St no. 2,242; W; B; BB.
Malaxis unifolia Michx. 11 no. C 2,194.
Pogonia ophioglossoides (L.) Ker. 9 no. 2,238; 12.
Spiranthes Romanzoffiana Cham. 11 no. C 2,093.

SALICACEAE

Populus balsamifera L. (P. tacamahacca Mill.). P; 2 no. 2,266; 3; Wo; B no. 2,265; 8; 9; 7I; 10; 11 no. C 2,164; 12.
P. tremuloides Michx. P; 2; 3; Wo; BB; B no. 2,264; 7; 8; 9; 7I; 10; 11; 12.
Salix cordata Muhl. P; Wo; B; 7; 8; 9; 7I no. 2,247; 10; 11; 12.
S. cordata x sericea. 8 no. 2,248.
S. discolor Muhl. B no. 2,255; 12.
S. humilis Marsh. 8 no. 2,256 and 2,257; 9; 10; 11.
S. lucida Muhl. 2; B; 7; 8; 9; 7I; 10; 11 no. C 2,131; 12.
S. lucida, var. intonsa Fernald. 11 no. 2,246.
S. pedicellaris Pursh. B no. 2,251.
S. pedicellaris, var. hypoglauca Fernald. B no. 2,252 and 2,253; BB no. 2,254.
S. pellita Anders. B no. 2,261; 8 no. 2,260; 9; 7I no. 2,263; 11 no. C 2,132; 12.
S. pellita, forma psila Schneider. 7I no. 2,259.
S. pyrifolia Anders. B no. 2,249 and 2,250.
S. Bebbiana Sarg. P; 2; 3; W; B; 8; 7I no. 2,258.
S. sericea Marsh. 3.

MYRICACEAE

Myrica Gale L. 3; 4; St; B no. 2,267; 7; 8; 7I; 10; 11; 12. Goodale reported Myrica "abundant and in full bloom" at B on May 26, 1862, see p. 338 (1862).

BETULACEAE

Alnus crispa (Ait.) Pursh, var. mollis Fernald. 8 no. 2,270; 9; 7I no. 2,271; 10; 11; 12.

A. incana (L.) Moench. P; 2; 3; 4; St no. 2,272; W; Wo; B; BB; 7; 8; 9; 7I; 10; 11; 12.

Betula papyrifera Marsh. P; 2; 3; 4; St; W; Wo; B; BB; 7; 8; 9; 7I; 10; 11; 12.

B. papyrifera Marsh, var. cordifolia (Regel) Fernald. St; W; B; BB; 7; 8; 10.

B. lutea Michx. f. P; 2; 3; 4; St no 2,269; W; Wo; B; BB; 7; 8; 9; 7I; 10; 11; 12.

Corylus rostrata Ait. P; 2; 3; 4; St no. 2,268; W; Wo; B; BB; 7; 8; 7I; 10; 11; 12.

FAGACEAE

Fagus grandifolia Ehrh. 2 no. 2,274; St no. 2,273; 7I. Recorded by Goodale at St. "on rises of land" p. 337 (1862).

URTICACEAE

Humulus Lupulus L. 3; 7I no 2,277; 11 no. C 2,060; 12.

Laportea canadensis (L.) Gaud. 2 no. 2,279; 3; W; 7I no. 2,280.

Ulmus americana L. P; 2 no. 2,275; 3; Wo; 7; 8; 9; 7I no. 2,280; 11; 12.

Urtica gracilis Ait. 7I no. 2,278; 11.

LORANTHACEAE

Arceuthobium pusillum Peck. BB no. 2,281.

ARISTOLOCHIACEAE

Asarum canadense L. 11 no. 2,282 and C 2,067.

POLYGONACEAE

Fagopyrum *tataricum* (L.) Gaertn. Reported (under Polygonum) by Goodale as "Cultivated on the banks of the St. John, by the

French who call it 'rough buckwheat.' Having escaped from fields it grows plentifully in the woods of upper St. John." See pp. 127, 369, 370 (1861).

Polygonum natans Eaton, f. Hartwrightii (Gray) Stanford. 8; 12 no. 2,283.

P. aviculare L. 11.

P. cilinode Michx. 8 no. 2,284; 9.

P. *Convolvulus* L. 7I.

P. Hydropiper L., var. projectum Stanford. 11 no. C 2,114 and C 2,189: 12.

P. lapathifolium L. 11.

P. *Persicaria* L. 11 no. C 2,189.

P. sagittatum L. BB; 11 no. C 2,144.

P. scabrum Moench. 11.

Rumex *Acetosella* L. P; 2; 3; 4; St; B; BB; 7; 8; 9; 7I; 10; 11; 12. Reported by Goodale from B as introduced at lumber camp, see p. 338 (1862).

R. Britannica L. 7I.

R. *crispus* L. 11.

R. *Patientia* L. P.

CHENOPODIACEAE

Chenopodium *album* L. Introduced at B, reported by Goodale, p. 338 (1862).

CARYOPHYLLACEAE

Arenaria lateriflora L., var. typica (Regel) St. John. 8 no. 2,258.

Cerastium *vulgatum* L. P; 2; 4; St; BB; 7; 8; 9; 7I; 10; 11; 12. Recorded (as C. viscosum) by Goodale p. 338 (1862).

Silene *latifolia* (Mill.) Britten & Rendle. Introduced at P; 9; 7I no. 2,289; 11 no. C 2,100; 12.

Spergula *arvensis* L. Introduced at P; 7I; 11 no. C 2,098.

Stellaria borealis Bigel., var. floribunda Fernald. B no. 2,286; 11; 12.

S. borealis Bigel., var. isophylla Fernald. B no. 2,287; St; W.

NYMPHAEACEAE

Nymphozanthus microphyllus (Pers.) Fernald. St no. 2,291; B; 7.

N. rubrodiscus (Morong) Fernald. 7I no. 2,290.

RANUNCULACEAE

Actaea alba (L.) Mill. 2; St no. 2,310.

A. rubra (Ait.) Willd. 3; St no. 2,309; W; 8; 9; 7I; 10; 11 no. C 2,184; 12.

A. rubra (Ait.) Willd., f. neglecta (Gillman) Robinson. 10 no. 2,308; 11; 12.

Anemone canadensis L. 11 no. 2,302, no. C 2,112; no. C 2,141.

A. riparia Fernald. 9 no. 2,300; 7I no. 2,301; 11 no. C 2,094; 12.

Caltha palustris L. 11 no. 2,306; 12.

Clematis verticillaris DC. 9 no. 2,305.

C. virginiana L. 2 no. 2,303; 3; 4; St; BB; 7I no. 2,304; 10; 11 no. C 2,205; 12.

Coptis trifolia (L.) Salisb. P; 2; 3; 4; St no. 2,307; W; Wo; B; BB; 7; 8; 7I; 10; 11 no. C 2,180; 12.

Ranunculus abortivus L. P no. 2,294; 2; 3; 4; St.

R. *acris* L. Introduced at 2; 3; 4; St; 7, 8; 9; 7I; 10; 11; 12.

R. *acris* L., var. *Steveni* (Andrz.) Lange. Introduced at 2; 4; 11.

R. aquatilis L., var. capillaceus DC. 7I no. 2,292.

R. reptans (L.) Mey. 4; B; 7I no. 2,293; 10; 12.

R. recurvatus Poir. 2 no. 2,296; B no. 2,295; 7; 8;.

R. repens L. 2; 4; 7I.

R. septentrionalis Poir. P no. 2,298; 2; 4; W; Wo; BB; B no. 2,297; 7; 8; 7I; 10; 12.

Thalictrum polygamum Muhl. Common. 12 no. 2,299.

BERBERIDACEAE

Caulophyllum thalictroides (L.) Michx. 3 no. 2,311.

CRUCIFERAE

Barbarea *vulgaris* R. Br. 7I.

Brassica *arvensis* (L.) Ktze. A weed at 7.

Capsella *Bursa-pastoris* (L.) Medic. Introduced at P; 2; 7; 7I; 12.

Cardamine pennsylvanica Muhl. P; 2 no. 2,312; St no. 2,313; W; B; BB; 8; 9; 7I; 10; 11.

Dentaria diphylla Michx. Alluvial woods at P; 2.

SARRACENIACEAE

Sarracenia purpurea L. St; BB no. 2,314.

DROSERACEAE

Drosera linearis Goldie. 11 no. 2,171.

D. longifolia L. 8; 10; 11 no. C 2,170; 12 no. 2,316.

D. rotundifolia L. BB no. 2,315; 8; 9; 10; 11 no. C 2,145 and C 2,169; 12.

SAXIFRAGACEAE

Chrysosplenium americanum Schwein. 2 no. 2,320; St no. 2,321; W; BB; B; 8; 10; 11.

Mitella nuda L. 2; 4; St no. 2,319; W; B; BB; 7; 8; 9; 7I; 10; 11 no. C 2,182; 12.

Parnassia caroliniana Michx. 8 no. 2,222; 9 no. 2,323; 10; 11 no. C 2,046.

Ribes lacustre (Pers.) Poir. P; 2; 4; St; W; Wo; B no. 2,324; BB; 7; 8; 9: 7I; 10; 11; 12.

R. prostratum L'Her. W; 12 no. 2,325.

R. triste Pall., var. albinervium (Michx.) Fernald. 2 no. 2,327; 4; St; W no. 2,326; BB; 7; 8; 7I; 10.

Tiarella cordifolia L. P no. 2,217; 2; 3; 4; St no. 2,318; W; B; BB; 8; 12.

ROSACEAE

Agrimonia gryposepala Wallr. Observed at 11; 12.

A. striata Michx. 11 no. C 2,064.

Amelanchier Bartramiana (Tausch) Roemer. 2; 3; 4; St; 7 no. 2,332.

A. Bartramiana x laevis. 2 no. 2,333; St no. 2,335.

A. laevis Wiegand. Observed at W; Wo; BB; 7; 10; 11.
Collections also thought in the field to be of this species from 2; St; 8; have been determined as hybrids of this with other species.

A. laevis x sanguinea. 8 no. 2,334.

A. sanguinea (Pursh) DC. 8 no. 2,337; 9 no. 2,336.

Crataegus sp. 8 no. 2,339; 9. Sterile specimens.

C. rotundifolia Moench. 11 no. 2,338; 12.

Dalibarda repens L. 7 no. 2,350, 10.

Fragaria virginiana Duch., var. terrae-novae (Rydb.) Fernald & Wieg. 2; 3; 4; Wo; 7; 8, 9; 7I; 10; 11; 12.

Geum rivale L. 3; St no. 2,345; W; 8, 10.

Potentilla Anserina L. 8 no. 2,344; 7I; 10; 11 no. C 2,051; 12.

P. arguta Pursh. 9 no 2,340; 12.

P. fruticosa L. 8 no. 2,342; 9; 10; 11 no. C 2,059; 12.

P. norvegica L. P; 4; B; BB; 7; 8; 9; 7I; 10; 11 nos. C 2,110, C 2,186; 12.

P. palustris (L.) Scop. B; 7I.

P. tridentata Ait. 8 no. 2,343; 9; 10; 11 no. C 2,091; 12.

Prunus pennsylvanica L. f. 2; 3; St no. 2,356; W; Wo; BB; BB; 7; 8; 7I; 10; 11; 12.

P. depressa Pursh. 9 no. 2,357; 7I; 10; 11; 12.

P. virginiana L. 3; St; W no. 2,355; Wo; BB; 7; 7I; 10; 11 no. C 2,085; 12.

Pyrus americana (Marsh) DC. P; 2; 3; 4; St no. 2,331; BB; 7; 8; 9; 7I; 10; 11; 12.

P. melanocarpa (Michx.) Willd. 3; St no. 2,329; BB no. 2,330; 11 no. C 2,086.

Rosa blanda Ait. 9 no. 2,351; 10.

R. johannensis Fernald. 11 no. 2,352; 12.

R. nitida Willd. 2; B no. 2,354; 7 no. 2,353; 8; 9; 7I.

R. virginiana Mill. 11 no. C 2,056.

Rubus idaeus L., var. canadensis Richards. B no. 2,346.

R. junceus Blanchard. 9 no. 2,349.

R. pubescens Raf. 2; 3; 4; St; W no. 2,347; Wo; B; BB; 7; 8; 9; 7I; 10; 11; 12.

R. recurvicaulis Blanchard 8 no. 2,348; 7I; 10; 11; 12.

R. setosus Bigel. 11 no. C 2,146.

Spiraea latifolia Borkh., var. typica Fernald. P; 2; 3; 4; St; B no. 2,328; BB; 7; 8; 9; 7I; 10; 11 no. C 2,087; 12.

LEGUMINOSAE

Astragalus alpinus L., var. Brunetianus Fernald. 7I no. 2,361; 11 no. C 2,105; 12. Recorded by Goodale p. 366 (1861) (as *A. alpinus*) from above 7I "to Grand Falls"; and " near Fort Kent" p. 126 (1861).

Desmodium canadense (L.) DC. 9 no. 2,364; 11 no. C 2,198; 12 no. 2,363.

Hedysarum boreale Nutt. 9 no. 2,362; 10; 11 no. C 2,090; 12.

Recorded by Goodale p. 126 (1861) on the "Main St John"; and on p. 126 (1862) as "Quite common and flourishing throughout the district", that is the St. John district.

Lathyrus palustris L. 8 no. 2,366; 9; 7I; 10; 12.

Medicago *sativa* L. P.

Oxytropis johannensis Fernald. Found by Goodale above 7I. See his notes pp. 126, 366, 367 (1861); 125, 339 (1862).

Trifolium *hybridum* L. P; 7; 8; 9; 7I no. 2,360; 12.
T. *pratense* L. P; 7; 9; 7I no. 2,359; 10; 11; 12.
T. repens L. P; 2; 4; St; 8; 9; 7I no. 2,358; 10 11; 12.
Vicia Cracca L. 4; St; BB; B no. 2,365; 7; 8; 9; 7I; 10; 11 nos. C 2,103, C 2,498; 12.

OXALIDACEAE

Oxalis montana Raf. P; 2 no. 2,367; 3; 4; St; W; Wo; B no. 2,368; BB; 7; 8; 7I; 10; 11; 12.
O. europaea Jord. P; 2; 3; 7; 8; 7I no. 2,369 10; 11 no. C 2,210; 12.

CALLITRICHACEAE

Callitriche palustris L. 2; 3, 4; B, BB; 7; 8; 7I no. 2,370.

ANACARDIACEAE

Rhus Toxicodendron L. 7I no. 2,371; 9; 12.

AQUIFOLIACEAE

Ilex verticillata (L.) Gray. B no. 2,372.
Nemopanthus mucronata (L.) Trel. St no. 2,373; B.

ACERACEAE

Acer pennsylvanicum L. P; 2; 3; 4; St no. 2,374; B; 10; 11; 12.
A. rubrum L. P; 2; 3; 4; St no. 2,377; W; B; 7; 8; 9; 7I; 10; 11; 12.
A. saccharum Marsh. P; 2; 3; St no. 2,376; B; 10; 11; 12
Goodale p. 369 (1861) noticed it from Black River down the St. John.
A. spicatum Lam. P; 2; 3; 4; St no. 2,375; W; Wo; B; 7; 8; 9; 7I; 10; 11 no. C 2,166; 12.

BALSAMINACEAE

Impatiens biflora Walt. P; St; W; 7I; 11; 12.

RHAMNACEAE

Rhamnus alnifolia L'Hér. St no. 2,378.

GUTTIFERAE

Hypericum boreale (Britton) Bicknell. 12.
H. ellipticum Hook. B; 8; 7I no. 2,379; 11 no. C 2,109; C 2,163; 12.
H. virginicum L. 4; B.

VIOLACEAE

Viola cucullata Ait. 3 no. 2,382; 4; St no. 2,381; B; BB; 7I; 10 no. 2,380; 11 no. C 2,128.

V. eriocarpa Schwein., var. leiocarpa Fernald. W no. 2,391.

V. incognita Brainerd. P; St; W nos. 2,389, 2,390; B; BB; 7; 8; 7I; 11; 12.

V. labradorica Schrank. 8 no. 2,392.

V. nephrophylla Greene. BB; 8 no. 2,383; 11 no. C 2,209.

V. novae-angliae House. 11 no. C 2,208a.

V. pallens (Banks) Brainerd. P; 3; 4; St no. 2,387; W no 2,388; Wo; B; 7; 8; 7I; 10; 11 no. C 2,130; 12.

V. renifolia Gray. W no. 2,385.

V. renifolia, var Brainerdii (Greene) Fernald. 2; St; W no. 2,385; B; BB; 7; 8; 7I; 10; 11 no. C 2,181; 12.

V. septentrionalis Greene. P; W no. 2,384; 7; 11 no. 2,208.

ONAGRACEAE

Circaea alpina L. P; 3; St; W; B no. 2,398; BB; 7; 8; 7I; 11 no. C 2,183.

Epilobium angustifolium L. P; 3; 4; Wo; B; BB; 7; 8; 7I; 10; 11; 12.

E. glandulosum Lehm., var. adenocaulon (Haussk.) Fernald. 7I no. 2,393; 11 nos C 2,087, C 2,137; 12.

Oenothera biennis L. 11 no. C 2,084; 12 no. 2,395

O. parviflora L. 7I no. 2,394.

O. perennis L. P; 4; BB no. 2,397; 8; 9; 7I no. 2,396; 10; 11 no. C 2,121; 12.

HALORAGIDACEAE

Myriophyllum tenellum Bigel. St no. 2,400; 8.

M. verticillatum L., var. pectinatum Wallr. 7 no. 2,399.

ARALIACEAE

Aralia hispida Vent. 3; St; 7 no. 2,402; 11 no. C 2,202; 12 no. 2,401.

A. nudicaulis L. P; 2; 3; 4; St; W; B; BB; 7; 8; 9; 7I no. 2,403; 11; 12.

A. racemosa L. 11 no. C 2,117; 12.

UMBELLIFERAE

Angelica atropurpurea L. 7I no. 2,414.

Carum *Carvi* L. P; 7.

Cicuta bulbifera L. B.

Conioselinum chinense (L.) BSP. 2; 3; 4; St; W; B; BB; 7; 8; 9; 7I no. 2,413; 10; 11 no. C 2,126; 12.

Daucus *Carota* L. 4.

Heracleum lanatum Michx. 2; 3; W; B; 7; 8; 9; 7I no. 2,412; 10; 11 no. C 2,149; 12.

Hydrocotyle americana L. 10 no. 2,405; 11 nos. 2,406, C 2,142.

Osmorhiza Claytoni (Michx.) Clarke. 2 no. 2,407; 3; 4.

Sanicula marilandica L. 2; 3; 7; 9 no. 2,404; 7I; 10; 11 no. C 2,070; 12.

Sium suave Walt. 7I no. 2,408; 11 no. C 2,063; 12.

Zizia aurea (L.) Koch. 2 no. 2,411; 8 no. 2,410; 9 no. 2,409; 7I; 10; 11; 12.

CORNACEAE

Cornus alternifolia L. f. B no. 2,421; 7I; 10.

C. canadensis L. P; 2; 3; 4; St nos. 2,415, 2,416; W; Wo; B; BB; 7; 8; 9; 7I; 10; 11; 12.

C. rugosa Lam. 11 no. 2,417; 12.

C. stolonifera Michx. P; 2 no. 2,419; 3; St no. 2,420; B; BB; 7; 8 no. 2,418; 10; 11 no. C 2,203; 12.

ERICACEAE

Andromeda glaucophylla Link. BB no. 2,434; B no. 2,433.

Chamaedaphne calyculata (L.) Moench. St; BB; B no. 2,435.

Chimaphila umbellata (L.) Nutt., var. cisatlantica Blake. 11 no. C 2,073.

Chiogenes hispidula (L.) T. & G. 2; 4; St; W no. 2,438; B; BB; 7; 8; 9; 10.

Epigaea repens L. 4; 7 no. 2,436; 8; 9; 10.

Gaultheria procumbens L. 4; 8 no. 2,437.

Kalmia angustifolia L. 4; BB no. 2,431; B; 7; 8; 9; 10; 11.

K. polifolia Wang. St; BB no. 2,432.

Ledum groenlandicum Oeder. B no. 2,428; BB; 8.

Moneses uniflora (L.) Gray. St no. 2,422; 10; 11 no. C 2,179.

Monotropa uniflora L. St no. 2,427; 11 no. C 2,195.

Pyrola asarifolia Michx. 8 no. 2,425; 7I no. 2,426; 10.

P. elliptica Nutt. 2; B no. 2,424; 7; 8; 7I; 10; 12.

P. minor L. 2 no. 2,423.

P. secunda L. 3; St; B; BB; 7; 8; 11 no. C 2,178; 12.

Rhododendron canadense (L.) BSP. BB no. 2,429; 8 no. 2,430. Observed by Goodale p. 338 (1862) on May 26 "abundant and in full bloom" at B.

Vaccinium caespitosum Michx. 8 no. 2,442.

V. canadense Kalm. 2 no, 2,441; 3; 4; St; W; B; BB; 7; 9, 7I; 10; 11; 12.

V. Oxycoccos L. BB no. 2,443. Goodale p. 337 (1862) saw it on the Carry at St.

V. pennsylvanicum Lam. 2; 7; 8.

V. pennsylvanicum, var. myrtilloides (Michx.) Fernald 8 no. 2,439; 9; 7I; 12 no. 2,440.

PRIMULACEAE

Lysimachia terrestris (L.) BSP. 2; 3; B; BB; 8; 7I no. 2,445; 10; 11 no. C 2,101; 12.

Primula mistassinica Michx. 8 no. 2,444; 9; 10. Goodale p. 338 (1862) records this at 8, at the "mouth of the South West or Boundary branch" . . . and he found the shore tinged in some places with the rosy hue of P. m.

Steironema ciliatum (L.) Raf. 7I no. 2,446; 11 no. C 2,062; 12.

Trientalis borealis Raf. P; 2; 3; 4; St no. 2,447; W; Wo; B; BB; 7; 8; 9; 7I; 10; 11; 12.

OLEACEAE

Fraxinus nigra Marsh. P; 2; 3; St no. 2,448; W; Wo; B; BB; 7; 8; 7I; 10; 11; 12.

GENTIANACEAE

Halenia deflexa (Sm.) Griseb. 7I no. 2,449; 10; 11 nos. C 2,071, C 2,485; 12.

APOCYNACEAE

Apocynum cannabinum L. 11 no. C 2,207.

A. medium Greene. 2; 3, 4; BB; 7; 8 no. 2,450; 9; 7I; 10; 11; 12.

CONVOLVULACEAE

Cuscuta Gronovii Willd. 11 no. C 2,201.

LABIATAE

Galeopsis *Tetrahit* L. 11 no. C 2,188.

G. *Tetrahit*, var. *bifida* (Boenn.) Lejeune & Courtois. 7I no. 2,452; 11 no. C 2,190; 12.

Lycopus americanus Muhl. 2; St; 8; 11 no. C 2,055.

L. uniflorus Michx. B.

Mentha arvensis L. 7I no. 2,454; 12.

M. arvensis, var. glabrata (Benth.) Fernald. 11 no. C 2,053.

Prunella vulgaris L., var. lanceolata (Barton) Fernald. P; 2; 3; 4; St; W; Wo; B; BB no 2,451; 7; 8; 9; 7I; 10; 11; 12.

Satureja vulgaris (L.) Fritsch. 9 no. 2,453; 11 no. C 2,061.

Scutellaria Churchilliana Fernald. 11 no. C 2,058.

SCROPHULARIACEAE

Castilleja pallida (L.) Spreng., var. septentrionalis (Lindl.) Gray. 9 no. 2,462; 7I; 10; 11 no. C 2,124; 12 J. F. Collins & E. F Williams, Allaguash Plantation. Recorded by Goodale p. 127 (1861) as the species from the "St. John".

Chelone glabra L. B; 7I.

Linaria *vulgaris* Hill. 7I no. 2,455.

Mimulus ringens L. B no. 2,456; 7I; 10.

Pedicularis Furbishiae Wats. 10 no. 2,464; 11.

Rhinanthus oblongifolius Fernald. 12.

Verbascum *Thapsus L.* 12.

Veronica americana Schwein. 4; St no. 2,457; W; 8; 12.

V. humifusa Dickson. 8; 11 no. 2,461.

V. scutellata L. B no. 2,458.

V. serpyllifolia L. 2 no. 2,460; B no. 2,459; BB; 10.

LENTIBULARIACEAE

Utricularia cornuta Michx. 11 no. C 2,107; 12 no. 2,467.

U. intermedia Hayne. 7I no. 2,465; 10; 12.

U. purpurea Walt. St no. 2,466.

OROBANCHACEAE

Orobanche uniflora L. 7I no. 2,468.

PLANTAGINACEAE

Plantago major L. P; 2; 3; 4; St; 7; 7I no. 2,469; 11; 12.

RUBIACEAE

Galium asprellum Michx. 2; 3; St; W; BB; 7; 9; 7I; 11 no. C 2,168; 12.

G. palustre L. St; B; 8; 9; 7I no. 2,470; 10; 11; 12.
G. triflorum Michx. P; 2; 3; St; W; B no. 2,471; BB; 7; 8; 7I; 11; 12.
Mitchella repens L. St.

CAPRIFOLIACEAE

Diervilla Lonicera Mill. 3; W; B; 7, 8; 9, 7I no. 2,472; 10; 11; 12.
Linnaea borealis L., var. americana (Forbes) Rehder. P; 2; 4; St; W; Wo; B no. 2,474; BB; 7; 8; 9; 7I; 10; 11; 12.
Lonicera villosa (Michx.) R. & S., var. Solonis (Eaton) Fernald. St.
L. canadensis Marsh. 2; 3; 4; St; W no. 2,473; B; BB; 7, 8; 7I; 10; 11; 12.
Sambucus racemosa L. P; 2; 3; St; W; B; 9; 7I; 12.
Viburnum alnifolium Marsh. P; 2; St; 7; 10 no. 2,475; 11; 12.
V. cassinoides L. St; BB; 7; 8 no. 2,480; 9; 10; 12
V. Opulus L., var. americanum (Mill.) Ait. 3 no. 2,478; W no. 2,476; Wo; 7I no. 2,477; 11 no. C 2,200.
V. pauciflorum Raf. 7 no. 2,479; 7I.

CAMPANULACEAE

Campanula rotundifolia L. P; 2; 8 no. 2,482; 9; 7I no. 2,481; 10; 11 no. C 2,050; *J. F. Collins & E. F. Williams*, July 27, 1900; 12.

LOBELIACEAE

Lobelia Dortmanna L. St.
L. inflata L. 7I no. 2,484; 11 nos. C 2,048, C 2,096.
L. Kalmii L. 11 no. C 2,047; 12 no. 2,483.

COMPOSITAE

Achillea Millefolium L. P; 2; 3; 4; St, B; BB; 7; 8; 9; 7I no. 2,503; 10; 11 no. C 2,052; 12.
Anaphalis margaritacea (L.) B. & H. P; 2, 3; 4; St; W; B; BB; 7; 8; 10; 11; 12. Goodale p. 338 (1862) found this on May 26, 1862 introduced at B.
A. margaritacea, var. occidentalis Greene. 9 no. 2,496; 10; 11; 12.
Antennaria canadensis Greene. 2 no. 2,501; 8 no. 2,502; 12.
A. neodioica Greene. 8 no. 2,498, 9 no. 2,497; 10; 11 no. 2,499; 12.
A. neodioica, var. chlorophylla Fernald. 2 no. 2,500.
Arnica mollis Hook. 9 no. 2,509; 10; 11.
Artemisia *vulgaris* L. 7I no. 2,507; 11 no. C 2,099.

Aster acuminatus Michx. 2; 3; St; W; B; BB; 8; 10; 11 no. C 2,068; 12.

A. cordifolius L., var. Furbishiae Fernald. 11 no. C 2,066.

A. longifolius Lam. 11 no. C 2,159.

A. longifolius, approaching var. villicaulis Gray. 11 no. C 2,155.

A. macrophyllus L. 11 no. C 2,167.

A. puniceus L. 7I; 10; 12.

A. umbellatus Mill. 2; 3; BB; 8; 9; 7I; 10; 11 nos. C 2,054, C 2,153; 12.

Chrysanthemum Leucanthemum L. 2 no. 2,505; 7; 8.

C. Leucanthemum, var. *pinnatifidum* Lecoq & Lamotte. BB; 9; 7I no. 2,504; 10; 11 no. C 2,120; 12. Recorded by Goodale p. 338 (1862) as introduced at B.

Cirsium *arvense* (L.) Scop. 2; B; 7; 8; 9; 7I; 11; 12.

C. *lanceolatum* (L.) Hill. BB; 7I.

C. muticum Michx. P; 3; 4; St; W; Wo; BB; 7; 8; 9; 7I; 10; 11 no. C 2,065; 12.

Erigeron hyssopifolius Michx. 10 no. 2,495.

E. *philadelphicus* L. 2.

E. ramosus (Walt.) BSP., var. septentrionalis Fern. & Wieg. 8; 9; 7I; 10; 11 no. C 2,079.

Eupatorium maculatum L. 11 no. C 2,082.

E. maculatum, var. foliosum (Fernald) Wiegand. 8; 9; 7I no. 2,485; 10; 12.

E. perfoliatum L. 11 no. C 2,158; 12 no. 2,486.

E. urticaefolium Reichard. 9 no. 2,487.

Gnaphalium *uliginosum* L. 12. Reported by Goodale p. 338 (1862) as introduced at B.

Hieracium *aurantiacum* L. P; 2; 4; St; B; BB; 8.

H. canadense Michx. 10; 11 nos. C 2,106, C 2,160; 12.

H. canadense, var. hirtirameum Fernald. 7I no. 2,516.

H. *Pilosella* L. St; B; BB; 8; 10.

H. *pratense* Tausch. 2; BB.

H. scabrum Michx. 11 no. C 2,095.

H. vulgatum Fries. 7 no. 2,515.

Lactuca canadensis L. 12 no. 2,514.

L. canadensis, var. latifolia O. Ktze, f. exauriculata Wiegand. 11 no. C 2,072.

L. spicata (Lam.) Hitchc. 11 no. C 2,119.

Petasites palmatus (Ait.) Gray. BB no. 2,508; 8; 9; 10; 11; 12.

Prenanthes altissima L. 11 nos. C 2,069, C 2,192.

P. racemosa Michx. 11 no. C 2,104. Goodale p. 366 (1861) reported this (as Nabalus) along slate shores above 7I and from there frequent down river to Woodstock, N. B.; and p. 126 (1862) from the "St. John District".

P. trifoliolata (Cass.) Fernald. B; 11 no. C 2,089.

Rudbeckia *hirta* L. 12.

Senecio aureus L. P; 2 no. 2,511; 3; 8; 10 no. 2,512.

S. pauperculus Michx., var. Balsamitae (Muhl.) Fernald. 8; 9 no. 2,510; 7I; 10; 11 no. C 2,113; 12.

S. Robbinsii Oakes. BB; B no. 2,513; Wo.

Solidago bicolor L. 10.

S. canadensis L. 11 no. C 2,154.

S. graminifolia (L.) Salisb. 11 no. C 2,162.

S. hispida Muhl. 10 nos. 2,488, 2,489; 12 no. 2,490.

S. humilis Pursh. 11 no. C 2,152.

S. juncea Ait. 9 no. 2,492; 10 no. 2,493; 11 no. C 2,080; 12 no. 2,494.

S. latifolia L. P; 2; 7I; 10; 11 no. C 2,191.

S. macrophylla Pursh. St; W; B; 7; 8; 7I no. 2,491; 10; 12.

S. rugosa Mill. 7I; 10.

S. rugosa, var. villosa (Pursh.) Fernald. 11 no. C 2,083.

Sonchus *arvensis* L. 11 no. C 2,127.

Tanacetum huronense Nutt. 11 no. C 2,057; 12 no 2,506. Reported by Goodale p. 127 (1861) "On the banks of the main St. John; not detected south of Seven Isles"; and p. 367 (1861) "common along the banks of the Upper St. John"; and p. 126 (1862) "plentiful in rocky soil and very thrifty . . . St. John district"; and p. 339 (1862) on May 28-29, 1862, when between 8 and 9, "river banks and woods".

Taraxacum *vulgare* Lam. P; 2; 3; 4; St; W; B; BB; 7; 8; 9; 7I; 10; 11 no. C 2,113a; 12.

DOUBTFUL RECORDS

Elymus species, introduced at B, fide Goodale p 338 (1862)

Myrica cerifera L. Reported by Goodale p. 127 (1861), "On the banks of the St. John." It is probable that his locality was outside of the area considered here.

Alsine Groenlandica Fenzl. Reported by Goodale on p. 126 (1861) from the "St. John". There has been no recent confirmation of this record.

Sagina. Goodale gives a description on p 126 (1861), of a species "found by me on the main St John."

Stellaria humifusa Rottb. There is a Goodale specimen in the Gray Herbarium labeled, "Upper St. John's River, Maine, 60 m. from Quebec, 1862." The identification is correct, but as this is the only inland station for the species, one suspects a confusion of data.

Anemone parviflora Michx Recorded by Goodale, p. 125 (1861). "Occurs plentifully on the rocky banks of the St John," and on p 366, "along shores, slate ledges, above Seven Isles." On p 125 (1862) Goodale states, "Abundant along the main river, in the disintegrating slates"

Ribes hirtellum Michx. Observed only at 2. No specimen preserved

Ribes rubrum L. Goodale listed it on p 338 (1862) as "very abundant, and an allied species, perhaps a variety of R rubrum, occurs with it." His locality was our 8, and the date May 27, 1862.

Rubus allegheniensis Porter. Observed at 12.

Astragalus sp ign. Recorded by Goodale p 125 (1862) in the St. John District, 8 and 9, records a species "plentiful along banks and nearby woods"

Astragalus sp ign Recorded by Goodale p 125 (1862) in the St John District, as "Much resembling A Robbinsii *Gray*, but appearing to possess specific differences"

Astragalus Robbinsii Gray Recorded by Goodale p 366 (1861) "along banks of the river from this point", T XI, R XVI above our 71 to Grand Falls; and p 126 (1861) from the "Main St John", and p 126 (1862) "Very abundant on the shores of the river St. John."

Lathyrus maritimus (L) Bigel Recorded by Goodale, p 126 (1861) from the "Main St John", on p 366 (1861) from near the Black River, "A singular species, but specimens were too mature to admit of proper determination" It seems probable that the plants were broad leaved variants of L. palustris

Viola palustris L Goodale p 338 (1862) on May 27, at 8, reported the shore "purple" with it There is no subsequent verification of this report

Viola n. sp. or a well marked var of V. palustris, is reported by Goodale p. 336 (1862) at locality 3

Artemisia borealis Michx Reported by Goodale p 125 (1862) as "Common in clefts of rocks along the shore, particularly near the falls . St. John District." This is probably outside of our area.

Artemisia canadensis Michx Reported by Goodale p 127 (1861) from the "St John", and p 126 (1862) as "Common in clefts of rocks along the shore, particularly near the falls . St John District." These are probably outside of our area.

Solidago Virga-aurea, var alpina Bigel Reported by Goodale p 126 (1862) on the "shore of St. John River"

Department of Botany,
State College of Washington

NEW AND NOTEWORTHY NORTHWESTERN PLANTS[1]

PART 2

HAROLD ST. JOHN

(Received for publication January 15, 1929)

ERYTHRONIUM REVOLUTUM Sm. This beautiful pink-flowered species can now be definitely recorded as a member of the flora of Washington. Mr Ira C. Otis found the plant on the west side of the Olympic Peninsula, and has deposited specimens in the Herbarium of the State College of Washington. These collections are from: in shade, Hoh River bottoms, elevation 100 feet, Jefferson Co., April 19, 1925, *I. C Otis* 1418; shaded hillside, Forks, Clallam Co., April 30, 1925, *I. C. Otis* 1428; open logged off land, near Lake Tyee, Clallam Co., April 29, 1925, *I. C. Otis* 1426.

Mr Otis writes, "In all cases the perianth is deep pink from the time it commences to open until it withers In the shade the leaves are beautifully mottled in shades of green I failed to note as to this in the specimens growing in the open. The mottling fades in the dried specimens The yellow spot at the base of the segments you can probably note as well as other details."

LEWISIA **exarticulata** n. sp.

Perennial; root a thick fleshy tuber, often somewhat divided below, 1-2 cm. long; leaves all basal, petioles narrowly winged 1-2 cm. long, the blades dark green and fleshy, obtuse glabrous, linear-oblanceolate to linear 2-3 cm. long, 1-5 mm. broad; scapes naked, not jointed, about half the length of the leaves, usually 1-flowered; floral bracts 2 opposite, attached 2-3 mm. below the terminal flower, oblong,oblanceolate, green and prominently veined, the margins thin and scarious towards the base and glandular-denticulate towards the tip, 2-4 mm. long; sepals 2 orbicular foliaceous, strongly veined, prominently glandular-denticulate, 3-4 mm. long, petals 8 greenish white 6-7 mm. long, the two outer ovate-oblanceolate and long apiculate, the six inner oblanceolate and short caudate; stamens 4, the filaments thin hyaline and narrowly deltoid 2.5 mm. long, the anthers lanceolate with the base somewhat sagittate 1 mm. long; stigmas 4 linear 1.5 mm. long; style none; capsule ovoid transparent circumscissile near the base; ovules about 24; seeds chestnut brown, flat on one side, low angular convex on the other, obovate-deltoid, emarginate at the hilum, 1.2-1.4 mm. long.

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[1] Contribution from the Botany Department of the State College of Washington, No. 20.

Perennis acaulis, foliis carnosis lineari-oblanceolatis, tepalis orbicularibus, glanduloso-denticulatis, petalis 8 oblanceolatis caudatis, antheris 4, stigmatibus 4.

Washington: Paradise Valley, Mt. Rainier, *J B Flett* 284; steep hillsides, summit trail, 6000-6500 ft, Panorama Pt., Mount Rainier, Pierce Co, Aug 13, 1927, *F A Warren* 751 (type in Herbarium of the State College of Washington).

Lewisia exarticulata belong to the group of species that were separated by Thomas Howell[2] as the genus *Oreobroma*, having the characters: sepals 2, stamens 5-20 or more, cotyledons incumbent, stems scapose and jointed at the base. He left in *Lewisia* only the original species, *L. rediviva* Pursh, having the characters: sepals 6 or 8 marcescent-persistent, stamens many, cotyledons accumbent, stems scapose 1-flowered with a whorl of bracts marking a joint near the middle. This seemed a very natural separation, and the genus *Oreobroma* is still maintained by Dr. Rydberg and by Tidestrom.

New evidence on these generic lines was brought forward by Mrs Katherine Brandegee.[3] She showed conclusively that the characters of the accumbent or incumbent cotyledons were not correlated with the other characters that were used by Howell. Then she described *L. rediviva*, var. ? *Yosemitana*, which still further complicated the question. It was said to have the pedicels jointed just below the flowers and crowned by three ovate scarious bracts, the sepals 2, the petals 5, the stamens about 15, and the flowers falling from the jointed pedicels even more promptly than in the species. Because of this description, Dr. B. L. Robinson in the Synoptical Flora[4] reduced *Oreobroma* to a section under *Lewisia*, but transferred *O. brachycalyx* and the similar *L. Kelloggii* to the section 1, including "Lewisia proper."

A similar treatment of the group has now been presented by Dr. W. L. Jepson.[5] Most of the species he keeps as subgenus *Oreobroma*, but puts into subgenus *Eulewisia*, *L. rediviva*, *L. yosemitana*, *L.*

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[2] Erythea 1: 31, 1893

[3] Proc. Calif. Acad. Sci. 2nd ser., 4. 86-91, 1894.

[4] Gray, Syn. Fl. 1, pt. 1: 267, 1897

[5] Man. Fl. Pl. Calif. 350, 1923.

brachycalyx, and *L. kelloggii.* The second of these is listed as *L. yosemitana* Jepson n. sp., based on *Jepson* 4357 from El Capitan. From that of *L. rediviva*, var. ? Yosemitana K. Brand., the description differs as follows: sepals 4-6, petals 7-11, stamens 16-26, and the flowers not disjointing from the plant on drying. Dr. Jepson adds, "perhaps the same as L. rediviva var. yosemitana K. Bdg." The type of the latter was "Collected somewhere about Yosemite Valley, by Mrs. Willie F. Dodd, in the summer of 1891." This type specimen was destroyed in the San Francisco fire.

Since the validity of the genus *Oreobroma* seems to depend upon the structure of this one var *yosemitana*, another discussion of it will be quoted. Dr. and Mrs H M Hall[6] write, "It was the first collected, 'somewhere about Yosemite Valley,' in 1891 by Mrs Willie F. Dodd. Then, after a period of twenty years, it was re-discovered by members of the Sierra Club party of 1911, who brought it in from the summit of Mt. Watkins and from the crown of El Capitan This material and the field notes taken by Professor Jepson, one of the collectors, indicate that our form is an exceedingly variable one The flower-stalks are jointed only near the base and are apparently without bracts, while in the type material as described by Mrs Brandegee, the stalks were jointed and bracted near the summit, from which the flowers promptly fell at maturity. There is also a wide variation in the number of flower-parts, indicating that this is only a variety of *L rediviva*, which differs chiefly in its larger size and greater number of sepals, petals, stamens, and style-branches"

It is not possible to reexamine the type specimen, since it was destroyed in the San Francisco fire. A sheet of this plant in the California Academy of Sciences, collected in Yosemite by *Enid Michaels* in April 1921, shows the scapes jointed near the summit, bearing 2-3 ovate bracts at the joint, and the sepals to be 2 in number.

It will be seen that this one plant, *Lewisia yosemitana* Jepson, or (K. Brand.) Jepson, as the authority should be written, though showing remarkable floral variability, breaks down, on the testimony of Mrs. Brandegee, Dr. Hall, and Dr. Jepson, the sepal character, the stamen character, the colyledon character, and the jointed stem character. Hence the *Oreobroma* group, though very unlike the true bitterroot, *L. rediviva*, will have to be restored to the genus *Lewisia.* The writer presents the preceeding facts and discussion, since many botanists, familiar with the two groups in the field, "have to be shown" that they are rightly placed in the one genus *Lewisia.*

The species *brachycalyx* and *Kelloggii* were transferred by Dr.

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[6] Yosemite Flora 85, 1912.

Robinson and by Dr. Jepson to the section or subgenus containing *L. rediviva*. They might equally logically be placed with the subgenus *Oreobroma*, thus following Howell's original study. Still, by the use of certain characters they can be grouped with *L. rediviva*. Since they are all to be in the genus *Lewisia*, the exact delimitation of the subgenera is not worth arguing about. According to the treatment by Dr. Jepson, the new *L. exarticulata* would be placed in the subgenus *Eulewisia*.

Mr. Warren, the collector of the type sheet, reports that he found the plants during his climb to the summit of Mt. Rainier. Three specimens were collected on a gravelly slope with low sparse vegetation of *Carex* and *Veronica*, near snow-line in the Arctic-alpine zone. It was necessary to carry the plants to the summit and back to Paradise Valley before they could be pressed. Flett's collection in the Herbarium of the State College of Washington consists of a single plant. This one furnished nearly ripe fruit, and confirmed the floral structure noted on the type. Thanks to a binocular microscope, the writer did not find it difficult to dissect the dried flowers, as Mrs. Brandegee did. Two flowers were carefully dissected, and these showed identical structure, with no variability in form or symmetry.

L. exarticulata is most closely related to *L. Kelloggii* K. Brand. That plant of the California Sierras differs in having, the fleshy root 4-5 cm. long; the leaf with the blade spatulate or obovate, mostly notched at the apex, the petiole as long as or twice as long as the blade; the peduncles joined at the base; the sepals ovate- or oblong-lanceolate, 8-10 mm. long; the petals 8-12 mm. long; the stamens 12-15; and the seeds semicordate. *L. exarticulata* is distinguished by having, the fleshy root 1-2 cm. long; the leaf with the blade linear-oblanceolate to linear obtuse, the petioles as long as or shorter than the blades; the peduncles not obviously jointed, remaining attached even after drying; the sepals orbicular, 3-4 mm. long; the petals 6-7 mm. long; the stamens 4; and the seeds obovate-deltoid. *L. brachycalyx* is somewhat similar, but it may be separated by having, the leaves spatulate or oblanceolate; the sepals not glandular-denticulate; the stamens 9-15; and the styles 5-7. On the other hand, *L. exarticulata* has the leaves linear-oblanceolate to linear; the sepals glandular-denticulate; the stamens 4; and the styles 4.

The specific name *exarticulata* is derived from the Latin, the prefix *ex* meaning non, and the adjective *articulatus* meaning jointed.

MONARDELLA ODORATISSIMA Benth. In his recent monograph[7] Dr. Carl C. Epling has revised the classification of this species and its variants. He recognizes six subspecies besides subsp. *euodoratissima* which represents the original plant. The characters used to separate the subspecies are largely in the amount and kind of pubescence of the leaves and bracts, and their shape. Epling's reasoning as to the value of these variations is as follows, "By reason of the fact that the species covers a wide range of territory, and since it does present differences in different parts of the range, an earnest but unsuccessful effort was made to find satisfactory criteria which would serve to divide the group into two or more clean-cut divisions. The subspecies here described represent the nearest approach to such an ideal. For convenience they might be called species and treated as such, yet it is the opinion of the author that no advantage would accrue, so numerous are the connecting forms, so profound is the effect of the environment, especially in numerous montane-desert stations where great extremes may occur within a relatively small radius of map distance and so close are the relationships of the subspecies."

The writer, while preparing to describe a color form recently discovered, has reexamined this group. The Herbarium of the State College of Washington contains a good representation of the three subspecies credited to the Pacific Northwest, two duplicate types and a tracing of a third. A large number of these collections were cited in Eplings' monograph. By the use of his key, they can in most cases be readily sorted into one or another of his three groups. That there is variation and that intermediate specimens occur, is readily confirmed. Plants which agree with the key in "appearing nearly or quite glabrous" should be studied with a low power hand lens. If a binocular microscope is used, many of them suddenly appear pubescent. The sheet, *Kreager* 499 from Myers Falls, Washington, came from within a very few miles of the type locality at Kettle Falls. Yet its leaves are so markedly puberulent as to make it intermediate to subsp. *discolor*. The collection *Whited* 195 from Wenatchee, Washington, cited as subsp. *discolor*, shows one branch that is clearly subsp. *discolor* and three that are intermediate towards subsp. *euodoratissima* From the existence of these intermediates and from the proximity of the geographic ranges, the writer is not convinced that these variants should have as an exalted a rank as the subspecies. They seem much more truly to represent varieties, as they are commonly interpreted. Hence the new combinations are here proposed for the three northern ones that have been restudied.

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[7] Ann. Mo. Bot. Gard. 12 57, 1925

MONARDELLA ODORATISSIMA Benth., var. **euodoratissima** (Epling) n. comb. *M. odoratissima* Benth., subsp. *euodoratissima* Epling, Ann. Mo. Bot. Gard. 12: 59, 1925.

That this variety grows in Idaho, has not been sufficiently emphasized. Dr. Rydberg in his Flora of the Rocky Mountains 751, 1917, credited the plant to Idaho, but Dr. Epling did not confirm this. To be sure one of his specimens, Clearwater, *Spaulding* (rather *Spalding*), should be credited to Idaho. The specimens collected by the Rev. Henry Spalding or his wife, came from the vicinity of Lapwai or Spalding, Nez Perce County, Idaho. Other records can be added:

IDAHO basalt rim of Snake River Canyon, south of Zaza, 5000 ft., alt, Nez Perce Co., July 28, 1927, *St John & Mullen* 8633; south of Zaza, Oct. 9, 1927, *St John* 9101.

M. ODORATISSIMA Benth., var. EUODORATISSIMA (Epling) St. John, forma **alba** n. f.

Floribus albis. Differing from the var. *euodoratissima* by having the corollas white.

WASHINGTON basalt gravelly ridge, 5500 ft. alt., Clayton Spring, T. 7 N. R. 39 E., Columbia County, Sept. 23, 1928, *H St John, J. A Moore, F H Smith & C. W VanAmburg* 9658 (type in Herb. State College of Washington)

This plant was collected during a trip over the new highway from Dayton, Washington, via Godman Springs and Toll Gate to Milton, Oregon. For some 40 miles this scenic road follows the main divide of the Blue Mountains at an elevation of from 5000 to 6000 feet. Many of the dry basalt gravel ridges are thickly tufted with the pungent lavendar-flowered *Monardella*. Only one albino was found among the thousands of the others.

M. ODORATISSIMA Benth., var. **discolor** (Greene) n. comb. *M. discolor* Greene, Pittonia 2: 24, 1889; *M. odoratissima* Benth., subsp. *discolor* (Greene) Epling, Ann. Mo. Bot. Gard. 12: 60, 1925.

M. ODORATISSIMA Benth., var. **glauca** (Greene) n. comb. *M. glauca* Greene, Pittonia 4: 321, 1901; *M. odoratissima* Benth., subsp. *glauca* (Greene) Epling, Ann. Mo. Bot. Gard. 12: 62, 1925.

Department of Botany,
State College of Washington.

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RESEARCH STUDIES
OF THE
STATE COLLEGE OF WASHINGTON

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Pullman, Washington
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VALIDITY STUDIES OF OBJECTIVE TESTS

CLIFF WINFIELD STONE

(Received for publication May 15, 1929)

This is, undoubtedly, the day of many tests. If safety does lie in numbers, we stand a good chance to be safe in tests The probability is, however, that numbers in this respect will bring safety only as they afford means of discriminating. The studies here reported are attempts to evaluate various types of so-called new-form examinations.

Objective tests have come into general use in the ten years since the war. Before 1920 there were only a few standardized tests. These were used almost exclusively for survey purposes, while the results of class-room teaching were measured almost entirely by the traditional, or essay, form of examination. The various uses of types in the army greatly accelerated the measurement movement. Standardized tests have increased by leaps and bounds until they now number in the hundreds, covering almost every subject taught in school, and they bid fair soon to cover every quality possessed by normal and abnormal individuals. Nor is this all. The making of tests has extended to the work of class-room teaching as such. It is with the latter so-called home-made or teacher-made tests that the studies here reported concern themselves. These home-made tests or new objective examinations have taken many forms. The more common forms are true-false, completion, multiple choice, and matching. Variations of these, and slightly different forms have increased the array until the number is little less than disconcerting to the typical classroom teacher. Odell published a bulletin in 1926 that treats of thirty-seven varieties of objective or near-objective tests.[1]

Some years ago, in the days before the number of new-form or objective tests was so great, I became concerned as to the relative value of those being used. The general superiority of the objective forms to the instructor was rather obvious from the first—so obvious that there seemed considerable danger that their value to the student might be neglected. No research was needed to demonstrate whether objective tests treated me, as a teacher, better than essay tests. The increase in my available time for home life, and for research, testified convincingly to that. But how about the students: How do they fare with objective tests as compared with essay tests; Which of the objective tests is best; Which of all the forms of tests *ranks students most nearly correctly?* That is, which form is the most valid? This is obviously an important question and it has proved to be a difficult and complex one.

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[1] Odell, C W., "Objective Measurement of Information", University of Illinois Bulletin, Vol 23 Number 36, 1926

In the belief that this problem must be solved, I began first by comparing the rankings of students by different forms of tests. It is needless to report that the correlation coefficients were low. This meant, of course, that at least one of the test forms was not ranking the students correctly; and the suspicion was strong that neither was ranking them correctly. This finding was troublesome enough; but the next problem was even more troublesome. This problem was, *What is the correct ranking of a class of students?* If we could just secure one correct ranking by some measure, it could be used as a basis of comparing the rankings by other measures; and we could, thereby, decide which form of test gave the most nearly correct ranking. That is, given one set of scores that rank a class correctly, we could then correlate the rankings of two or more test forms with the correct (criterion) scores. Then the test form whose coefficient was highest would thereby be indicated as the most nearly like the criterion in its ranking and therefore the most correct in this respect. Query, then, *How can we get a correct ranking?*

The answer was (and is) quite obvious: there is no way by which we can get a *correct* ranking. In other words, there are no measurements that are perfect in validity, and there is no likelihood of there being any for some time. This, in spite of the hopes and the strivings of scores of education research workers. Unfortunately, educational measurements are the product of human workers, and they are used on very human cases. We therefore have very human results.

SEARCH FOR THE BEST CRITERION

But if no measurements are correct in validity, are there some that are better than others? If so, what are the better ones? Even if we can not get a perfect criterion, can we get better criteria? Obviously, yes. We can use our best judgment. We can take special care and we can use scores from tests with high reliability (reliability is one of the most potent factors conditioning validity, and it is comparatively easily determined). Then, if we have secured as many measures of probable worth as is practicable, we can compile them into a composite measure —this on the assumption that the composite of several measures is of more value than any one measure; and on this assumption the composite score may be regarded as the best criterion with which to correlate scores from various forms of tests.

CRITERIA USED

Scores from six different sources have been regarded as worthy of serving as criteria. They are: composite term grade, intelligence test, vocabulary test, average of all college grades, the average of all previously secured grades in the subject in which the study was being made, and a composite of the foregoing five. This last would seem to be better (more valid) than any of the others taken alone.

The *composite term grade* is a statistically derived average of the available scores secured for each student during a given term in the subject in which scores are being studied. In most instances the composite term grades in these researches were constructed from essay grades secured during the term, objective test grades secured during the term, the final essay grade, the final objective test grade, and the "teacher's judgment" grade.

The *intelligence scores* were secured through the use of well established group intelligence tests.

The *vocabulary scores* were from either the Thorndike Test of Word Knowledge or the Inglis Vocabulary Test.

The *average of all college grades* was secured by combining for each student all his grades previously secured in State College courses Due care was taken to give the proper weight for the respective number of hours for each grade.

The *average of all previously secured grades* in the subject in which the investigation was being conducted was secured in the same way as the average of all college grades.

The *composite of all the grades* secured from the five sources was computed with due care with reference to the variability of each of the sets of scores.

After securing criteria, the procedure was that of correlating scores from the respective tests being investigated with the available criteria and comparing the size of coefficients.

ILLUSTRATIVE COMPARISON OF COEFFICIENTS

Two sets of comparisons will be quoted as illustrations. They are from the studies of Mr. Simpson and Miss Quarels as listed below. The comparisons from Mr. Simpson's study are from true-false and essay tests in Psychology.

The true-false correlated with intelligence scores gave a coefficient of .54
The essay correlated with intelligence scores gave a coefficient of .... .40

This shows .14 in favor of the true-false.

The true-false final correlated with college grades .... .51
Essay final correlated with college grades .... .56

This shows .05 in favor of the essay.

The set of illustrative comparisons from Miss Quarel's thesis is from best answer-completion tests and essay tests in High School Home Economics (clothing).

The best answer final correlated with Thorndyke Word Knowledge .581
The essay final correlated with Thorndyke Word Knowledge ...... .401

This shows .180 in favor of the best answer-completion.

The best answer final correlated with intelligence scores .... .310
The essay final correlated with intelligence scores .... .455

This shows .145 in favor of the traditional.

RESEARCH IN TEST FORMS AT THE STATE COLLEGE OF WASHINGTON

Eight M. A. theses have been completed at the State College of Washington on objective tests. These theses are available in the college library. They are:

New Forms of Examination in Zoology. Frank A. Roberts.

True-False Foods Test for High School Students. Laura M. Magruder.

Validity of the True-False Form of Examination in Secondary United States History. Emory C. Lathrop.

The True-False Form of Examination in Education and Psychology Courses. Percy Roy Simpson.

Validity of a True-False Test in Foods. Hazel M. Landin.

Best Answer-Completion Examination. Philip Albert Bennett.

A Best Answer-Completion Form of Examination in Clothing. Ruth Ellen Quarels.

Best Answer-Completion Form of Examination in Foods. Kathryn Ruth Denniston.

The main problems investigated by Mr. Roberts and Mrs. Magruder were in the general line of devising the various objective types of tests. The other six deal mainly with the determination of relative validity.

Mr. Lathrop's thesis does not show probable errors of his coefficients. Hence, it was impossible to include it in the summary of results given in Tables 1 to 4 of this study.[9]

The scope of these validity studies is indicated in Table I. Approximately 20,500 scores were utilized in the true-false studies and 18,400 in the best answer-completion studies. One hundred forty-five pairs of coefficients (290) were computed in the true-false investigation and 91 pairs of coefficients (182) in the best answer-completion investigations. Returns, from 1,947 students were canvassed in the true-false, and 1,740 in the best answer-completion.

TABLE 1.

DATA UTILIZED IN THE VALIDITY STUDIES

Table 1A. True-False.

	No. Scores	Number Pairs of Coefficients	No Students
Simpson			
College Psychology and Education	9,000	44	339
Landin			
High School Foods	6,000	57	1,303
Lathrop			
High School U S History	5,500	44	305
Totals	20,500	145	1,947

Table 1B. Best Answer-Completion.

	No Scores	Number Pairs of Coefficients	No Students
Bennett			
College Psychology and Education	5,400	28	204
Quarels			
High School Clothing	7,000	32	810
Denniston			
High School Foods	6,000	31	726
Totals	18,400	91	1,740

PRECAUTIONS IN SUMMARIZING RESULTS

In summarizing the results of the eight theses, care has been taken to include only reliable findings.

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[9] Mr Lathrop's findings were decidedly in favor of the essay over the true-false as used in high school United States History

Certain of the coefficients obtained were not high enough to indicate the best of reliability; however, it must be remembered in this connection that there were no corrections made for the effect of attenuation, and it is also important to recall that these coefficients were secured from groups of comparatively narrow range—one year, plus a few advanced students. The effect of these two factors is to reduce the size of coefficients to a considerable degree. In the summary and interpretation here made, *no coefficients are compared* that are not large enough to show reliability of at least four times the probable error. Tables 2 and 3 summarize these findings.

An additional precaution was taken *in summarising the results of these studies* in that the *reliability of the differences* between the two coefficients of each pair was computed. The formula used was:

$$\text{P E. diff} = \sqrt{PE^2_{r_1} + PE^2_{r_2}}$$

Tables 4 and 5 show the reliability (of differences) findings.

TABLE 2.

A COMPARISON OF THE DEGREE TO WHICH TRUE-FALSE AND ESSAY TEST RANKINGS CORRESPOND WITH CRITERIA RANKING

Investigator	Subject	Correlations with Criteria		
		No pairs of r's	No for T-F	No for Essay
Simpson[3]	Psychology	18	9	9
Simpson[3]	Principles of Education	11	9	2
Landin[4]	Home Ec. (Foods)	27	11	16

TABLE 3.

A COMPARISON OF DEGREE TO WHICH BEST ANSWER-COMPLETION AND ESSAY TEST RANKINGS CORRESPOND WITH CRITERIA RANKING

Investigator	Subject	Correlations with Criteria		
		No pairs of r's	No. for BA-C	No for Essay
Bennett[3]	Psychology	7	5	2
Bennett[3]	Principles of Education	18	14	4
Denniston[4]	Home Ec. (Foods)	19	16	3
Quarels[4]	Home Ec. (Clothing)	14	8	6

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[3] Mr. Simpson's and Mr Bennett's scores were made by upper class college students.

[4] Miss Landin's, Miss Denniston's, and Miss Quarel's scores were made by lower class high school students.

Interpreting Tables 2 and 3 it will be seen that the comparisons are on the whole in favor of objective tests. This is especially true of the best answer-completion form as compared with the essay. The true-false is shown to rank students more nearly like the criteria in Principles of Education; the true-false and essay are tied in psychology; and the essay is ahead in high school home economics. The essay was also shown by Mr. Lathrop to be ahead in high school U. S. history.

A study of Table 3 indicates that the best answer-completion form is ahead in all four subjects.

The reliability of these comparisons is recorded in Tables 4 and 5.

TABLE 4.

DEGREES OF RELIABILITY OF DIFFERENCES BETWEEN COEFFICIENTS TRUE-FALSE AND ESSAY

	Differences between Coefficients favoring T-F over Essay						Differences between Coefficients favoring Essay over T-F					
Reliability of Difference	100		75 99		50-74		100		75-99		50-74	
	No	%	No	%	No	%	No	%	No	%	No	%
Psychology			3	17	6	33			1	6	8	44
Principles of Education			6	55	3	27			2	18		
Home Ec. (Foods)	3	11	3	11	5	19	4	15	12	44		

TABLE 5.

DEGREES OF RELIABILITY OF DIFFERENCES BETWEEN COEFFICIENTS BEST ANSWER-COMPLETION AND ESSAY

	Differences between Coefficients favoring B A.-Com. over Essay						Differences between Coefficients favoring Essay over B.A -Com.					
Reliability of Difference	100		75-99		50-74		100		75-99		50 74	
	No.	%	No	%	No	%	No	%	No	%	No	%
Psychology			1	14	4	57			2	29		
Principles of Education	2	11	6	33	6	33			1	6	3	17
Home Ec. (Foods)	1	5	8	42	7	37			2	11	1	5
Home Ec. (Clothing)			6	43	2	14			6	43		

Read Table 4: In Psychology classes there were no pairs of coefficients with differences favoring the true-false form that were large enough to be reliable to the extent of 100 chances in 100 that there is a true difference in favor of the true-false form over the essay; there were 6 pairs (55% of all computed) with differences reliable to the extent of 75 to 99 chances in 100 that there is a true difference in favor of the true-false forms, etc.

Read Table 5 similarly to Table 4. Tables 4 and 5 summarize the degrees of reliability of the differences between coefficients. In columns headed 100 are entered the number (and per cent) of the differences that were large enough to have perfect reliability; in the columns headed 75 to 99 are entered the number (and per cent) of the differences that were large enough to have somewhat less than perfect reliability; and in the columns headed 50 to 74 are entered those with low reliability. Reliability as here used is computed by utilizing the probable error of each of the two coefficients compared as to size. The statistical procedure is such that degree of reliability is expressed in terms of the number of chances in 100. Chances may vary from 50 in 100, to 100 in 100. For example, reading for Home Economics (Foods) in Table 4, we see that in three of the pairs of coefficients that favored the true-false over the essay, the difference is large enough so that there are 100 chances in 100 (practical certainty) that a true difference between the coefficients exists; there are three pairs (11% of all computed) for which the difference is such that the reliability (of the difference) is 75 to 99 chances in 100 that a true difference exists; and there are five pairs (19% of all computed) for which the difference is such that the reliability is only 50 to 74 chances in 100 that a true difference exists. Passing to the right hand part of Table 4, it is seen that in Home Economics the showing is in favor of the essay form over the true-false form of test. The superiority of the essay form is found in both the number and the reliability of differences. There are four pairs for the essay (as compared with three for the true-false) with differences sufficiently high to yield reliability of 100 chances in 100, and 12 pairs (as compared with three) that yield reliability of 75 to 99 chances. Thus it is seen that there are more pairs of coefficients for Home Economics (Foods) in which the difference favors the essay and that there is higher reliability of the differences between the coefficients that favor the essay. Hence it appears that the essay form is here shown to have the greater validity in Home Economics (Foods).

In Principles of Education the results favor the validity of true-false, though not decisively; and in Psychology the results are slightly in favor of the true-false.

In Table 5 the findings are in favor of the best answer-completion over the essay form in all four subjects, though not markedly so for Psychology and Home Economics (Clothing). This appears to show that the best answer-completion form is more valid than the essay form in these four subjects.

While these studies show no absolute proof, yet it may be inferred from a comparison of the degree to which the true-false-essay findings in validity are exceeded by the best answer-completion-essay findings, that the best answer-completion is probably slightly more valid than the true-false. Obviously, there is great need for research which compares directly the validity of true-false and best answer-completion forms.

By way of summary, the interpretation of the validity findings of these studies of objective tests indicates:

1. That the relative merits of the many varieties of tests afford a large field for needed research.
2. That there is crucial need of valid criteria for comparison of scores from various types of tests.
3. That studies herein summarized indicate that the true-false is slightly more valid than the essay.
4. That these studies show that the best answer-completion is also somewhat more valid than the essay.
5. Though not directly shown, it would appear from indirect comparison that the best answer-completion is probably somewhat more valid than the true-false.
6. That studies in direct comparison of the validity of the various forms of objective tests are essential to their most effective use.

School of Education,
State College of Washington.

TERATOLOGIC FORMS OF TRILLIUM OVATUM AND TRILLIUM PETIOLATUM[1]

Rocelia Catherine Palmer

(Received for publication May 22, 1929)

The phenomenon of teratology was brought to the attention of the author through the receipt of a polypetalous specimen of *Trillium ovatum* Pursh. Variability has long been noted in the genus *Trillium*. Almost all of the parts of the plant are subject to deformity.

From the numerous publications on the teratology of *Trillium* it is evidently a subject that has incited widespread interest. Two valuable papers have appeared recently in which are given a summary of the recent literature. These papers are independent, though they supplement each other in content. The first, by Professor T. H. Goodspeed, contains a summary of the literature that appeared before 1916. The second is that of Dr. R. R. Gates, in which he gives an abstract of the teratologic literature on *Trillium* that appeared before 1917.

Below is a brief abstract of the material that has been published since 1917 on the subject of malformation in the genus *Trillium*.

T. H. Goodspeed, "Teratological Variations of Trillium Sessile var. Giganteum H. & A.", Univ. of Calif. Pub. Bot. 7: 69-100, 1916. Professor Goodspeed's article describes seventeen teratologic variations of *T sessile* var. *giganteum* In this article he also gives a list of the more important accounts of abnormal forms of Trilliums.

R. R. Gates, "A Systematic Study of the North American Genus Trillium, Its Variability, and Its Relation to Paris and Medeola.", Ann. Mo. Bot. Gard. 4: 69-87, 1917. In this article Dr. Gates gives a description of each of the species of *Trillium*, and includes a map showing their distribution

W E. Saunders, "Unusual Form of Trillium Grandiflorum", Canadian Field Nat. 39 · 149, 1925. In this article Mr. Saunders gives a general description of the variations of *T. grandiflorum* that were found in an area extending from London, Ontario, to a point about 80 miles east along Lake Erie and some distance southwest. In the latter part of the paper he described in detail the abnormalities of several individual plants.

F. M Andrews, "Reversion in Trillium", Indiana Acad. Sci. 36: 225, 1926. After an extended observation of twenty-three years Mr. Andrews concluded that monstrosities are less common in *T nivale* than in other species observed. During this same period he noted a number of variations in *T sessile, T recurvatum,* and *T erectum*

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[1] Contribution from the Department of Botany, State College of Washington, No. 23.

F. M. Andrews, "Monstrosities in Trillium", Indiana Acad. Sci. 37: 325, 1927. In this article Mr Andrews gives some further observations of the species mentioned in the article previously cited.

L. K. Beyer, "A Green Form of Trillium sessile", Torreya 27: 83-84, 1927 This describes an interesting color variation The specimens of this green-flowered form of *T. sessile* were found one and one half miles east of Bethany College, Bethany, W Va, growing with the true species. Intermediate color variations were found between the distinct purple and the green ones These intermediate forms had yellowish-green petals streaked with purple

C A Weatherby, "Tetramerism in Trillium undulatum", Rhodora 29. 223, 1927 In this article Mr Weatherby cites three specimens of *T undulatum* which he found near Salisbury, Conn The leaves, sepals, petals, stigmas, and cells of the ovary were in fours. The stamens had maintained their usual ratio of two to each petal, and were therefore eight in number.

C H Knowlton, "Tetramerism in Trillium grandiflorum", Rhodora 30: 105, 1928. This is an account of a completely tetramerous flower of *T grandiflorum* This specimen was one of many that he transplanted to his garden. He first noted it in flower in 1925 In 1926 it did not bloom but in the following year it flowered again.

It is the purpose in the present paper to describe some twenty abnormal forms of *Trillium, T. ovatum* Pursh, and *T petiolatum* Pursh. In the spring of 1928 scores of specimens of both species were examined. These examinations were made in the vicinity of Pullman, Washington, and Moscow Mountain, Idaho.

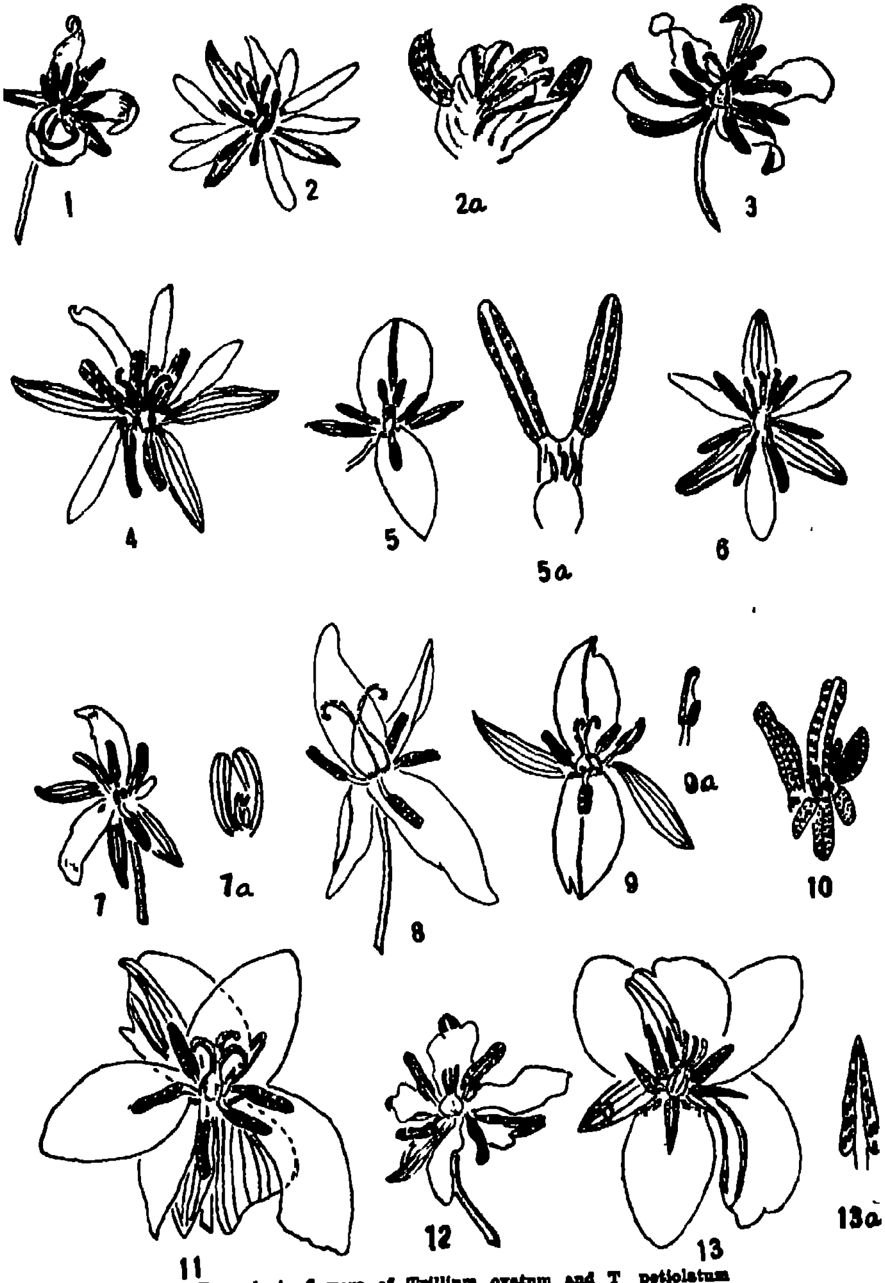
For convenience, the specimens will be treated in the following order to illustrate the several conditions: polyphylly, polypetaly, chloropetaly, heteramery, dimery, and tetramery.

The specimens considered in this paper are in the Herbarium of the State College of Washington. In this discussion they will be referred to by numbers. The collector's number, the date, and place of collection, will be found with the explanation of the figures. Figures one to thirteen are illustrated in Plate 4. Numbers fourteen to twenty-one inclusive are only described in the text.

POLYPHYLLY

Two specimens, one of *T. ovatum,* and the other of *T. petiolatum,* numbers 20 and 21, belong to this group. The specimen of *T ovatum,* number 20, has four leaves, three of which are normal and well formed. The fourth leaf is larger than the others and is bifid half way to the

PLATE 4



Teratologic flowers of Trillium ovatum and T petiolatum base, thus giving this specimen the appearance of having five leaves.

The second example of this class, a specimen of *T. petiolatum*, number 21, has the leaves in two whorls, each whorl consisting of three leaves. The leaves of the lower whorl, which are normal in size and shape, are alternate with those of the upper whorl. The first leaf of the upper set is orbicular and is 2 cm. shorter than the lower leaves. The second leaf is lanceolate while the third or inner leaf is very small, linear-lanceolate and almost sessile.

POLYPETALY

Two specimens of *T ovatum* belonging to this group will be described under figure 2 and number 16. The leaves of the specimen shown in figure 2 are normal in position, size, and shape. The flower, which is borne on a short pedicel 2.5 cm. above the leaves, has three normal sepals and nine petals. Eight of the petals of this flower are obtuse, but the ninth is acuminate. There are six normal lanceolate anthers. The unusual reproductive structure is shown in figure 2a. The small structure on the left is a modified stamen, with a pistillate flange on one side. This modified stamen is attached to the malformed ovary. In the other small stamen, as seen on the right, part of the anther has been modified into a petaloid structure which has an anther-like tip. The ovary is curved, resembling the profile of an inverted keel of the flower of a lupine. On the top of the twisted ovary are two small, distinct pistils, which appear to arise from the base.

The leaves and sepals of the second specimen, number 16, are normal. The thirty-six petals are arranged in whorls of three, with each successive whorl alternating with the one preceding. The petals in the first whorl are 3.8 cm. long and those of the fourth are 2 cm. long. The succeeding whorls become shorter until the innermost petals are about 2 mm. long. The inner whorls, starting with the eighth are concave. This specimen has no stamens, pistils, or ovary.

CHLOROPETALY

Under this heading six specimens will be described as figures 11, and 13, and numbers 14, 15, 17, and 18.

The asymmetry of the flowers of *T. ovatum*, shown in figures 11 and 13, is their most distinctive feature. The specimen illustrated by figure 11 has three normal leaves, one normal sepal, and two that are petaloid on one side. The dotted lines show the shape of the underlying parts. The petals and parts of petals that are shown without lining are normally white. The specimen shown in figure 13 has three normal leaves and three normal petals. One of the sepals is normal, and two are petaloid. The six anthers are sagittate. This specimen has three recurved stigmas that are all turned to the same side. Figure 13a shows the shape of the stamens.

The flowers of the plants numbered 14, 15, 17, and 18, specimens of *T. ovatum,* were borne on separate stalks, each of which has three normal leaves. Each of the flowers except the flower of number 17, which has two stigmas, has three normal petals, six stamens, and three stigmas. The specimens described as numbers 14, 15, and 17 have two normal green sepals and a third chloropetaloid one. The flower of figure 18 has two chloropetaloid sepals and one normal green one.

During the examination of the many *Trillium* specimens different degrees of chloropetaly were found to be very common. The degree varies from the asymmetrical conditions shown in figures 11 and 13, to flowers nearly normal, as those described in numbers 14, 15, 17, and 18. There seems to be a tendency for these chloropetaloid flowers to develop with the normal number of three sepals and three petals. Generally, there are three perfect petals and one or two normal sepals with the remaining one or two sepals partially petaloid. Thus, if there are two normal sepals and three petals, there is a fourth structure partly green and partly white. The morphological development of such a structure might be interesting to trace.

HETERAMERY

Seven specimens have been observed which belong to this group. They are illustrated by figures 1, 3, 4, 6, 7, 10, and 12.

The flower shown in figure 1 is represented by a specimen of *T. ovatum,* which has the normal number of leaves and sepals. Two of the petals are well formed, but the third has an anther-like phlange on the inner side, thus giving this petal a falcate appearance. There are five normal stamens and three small straight stigmas.

Examples of *T. petiolatum* are shown in figures 4 and 6. The specimen described as figure 4 has three normal petaloid, ovate leaves, three sepals and four petals. The tip of one petal is bent like a shepherd's crook. This specimen has five stamens, and three normal, reflexed stigmas.

The most unusual feature of the flower in figure 6 is the one functional stamen. The others were formed but had a withered appearance. The tips of the three stigmas have a hooded, petal-like structure about 1 mm. long.

The perianth parts of the flower shown in figure 7 are normal except for a much reduced petal on the right. The sexual organs of this example of *T. ovatum* are deformed The flower has four perfect stamens, and two small sessile ones 3 mm. in length Sheathed by these small stamens is the very small ovary with its three stigmas, which together do not exceed 1 mm. in length.

Of all the specimens seen, figure 12 shows perhaps the most uncommon form. This specimen has three normal leaves, one sepal, and five petals. The petals of this flower are irregular in outline and size. The staminiferous tips of the petals are unusual. The ovary with its non-recurving stigmas is common, though not a normal condition. When this condition of stigmas occurs, the writer has noted that these organs do not have the normal vigorous and healthy appearance.

The flower depicted in figure 3 has three leaves, one distinct sepal, and a second sepal with a petaloid portion on one side, and a third sepal with a petaloid portion in the center. The sexual parts of the flower consist of six stamens and an ovary with two stigmas.

In the course of the examination of the species considered in this paper, many specimens were found with minute flower buds. Figure 10 is from an enlarged drawing of such a bud of *T petiolatum* When this specimen was found, only the three leaves, one sepal, and one stamen were visible. The surface of the five small petals and the sepal are covered with opaque dots. These dots when examined under a compound microscope appear to be thickened cells which are probably filled with calcium oxalate crystals. The large stamen is 8 mm long. There are also two smaller ones, 1 2 mm long, enclosing three minute stamens These very small stamens are translucent and apparently abortive, though they do have the longitudinal lines of dehiscence.

DIMERY

The four plants of *T. ovatum* in this group are represented by figures 5, 8, 9, and number 19. The plant shown in figure 5 has two leaves, two linear sepals, 8 mm. x 4 mm , and two petals, one of which is linear-ovate, and acutely pointed, while the other is broadly ovate with a virescent mid-stripe. Perhaps the most unusual thing about this plant is the fusing of the two filaments, thus giving the appearance of the two anthers growing on one filament. Figure 5a is from an enlarged drawing of the fused filament and its two anthers; also the small undeveloped ovary with three stigmas is shown.

A specimen which has all of its parts in the multiple of two is shown in figure 8. It has two leaves, one normal and the other enlarged and bidentate at the tip The perianth and sexual parts though not consisting of the usual number, are well formed.

In figure 9 and number 19 the parts of the plants are in the multiple of two The petals of figure 9 have a green midvein, and dentate tips. Figure 9a illustrates the malformed stamen. The lower petal of number 19 also has a green midvein The ovary and stigmas of number 19 are undeveloped and probably incapable of setting fruit.

TETRAMERY

The phenomena of tetramerism was noted but once in this study, in a specimen of *T petiolatum*, number 22. This plant has four leaves, four sepals, four petals, seven stamens, and four stigmas

During the spring of 1928 the author noted the abundance of teratologic specimens of *T ovatum* The malformed plants were observed growing with the normal forms Scores of specimens of *T petiolatum* were also observed at the time of this study, but only four abnormal forms were found In the literature concerning these two western species, only one citation of *T ovatum* was found, and none of *T. petiolatum* This one citation of *T ovatum* concerns a specimen from Lake Cushman, Washington, collected by Mr. W. T Putnam, and was described by Mr. Walter Deane in Rhodora 13. 189-191, 1911.

Grateful acknowledgement for suggesting the problem, and for assistance in the preparation of this paper should here be made to Dr. Harold St John.

EXPLANATION OF FIGURES

Figure 1 Trillium ovatum showing the scythe-like lower petal, Rocelia Palmer 229, May 26, 1928, Moscow Mountain, Idaho

Figure 2 Trillium ovatum showing the nine petals, Rocelia Palmer 227, Apr 1928, Arlington, Washington

Figure 2a Showing the ovary with small stamens

Figure 3 Trillium ovatum, an interesting example of chloropetaly, Rocelia Palmer 230, May 26, 1928, Moscow Mountain, Idaho.

Figure 4 Trillium petiolatum, an example of a heteromerous plant, Rocelia Palmer 233, May 12, 1928, Kamiak Butte, Washington.

Figure 5 Trillium ovatum, a specimen with dimerous parts, H. W. & M. T. Crowley, Apr. 1928, five miles south west of Deer Park, Washington

Figure 5a. Showing the fused filament.

Figure 6. Trillium petiolatum showing the petaloid tips of the anthers, Rocelia Palmer 228, May 12, 1928, Kamiak Butte, Washington

Figure 7. Trillium ovatum, Rocelia Palmer 234, May 26, 1928, Moscow Mountain, Idaho

Figure 7a. Showing an enlarged drawing of the minute ovary

Figure 8. Trillium ovatum, a perfect dimerous flower, Rocelia Palmer 238, May 26, 1928, Moscow Mountain, Idaho.

Figure 9 Trillium ovatum showing virescent streaking, H St. John 9377, May 12, 1928, Kamiak Butte, Washington.

Figure 9a Showing the malformed anther

Figure 10 Trillium petiolatum. The black dots represent opaque dots, Rocelia Palmer 232, May 12, 1928, Kamiak Butte, Washington

Figure 11 Trillium ovatum showing the shape of the petals, H. W & M T. Crowley, Apr 1928, five miles south west of Deer Park, Washington

Figure 12 Trillium ovatum showing the stamniferous tip of the petals, Rocelia Palmer 235, May 26, 1928, Moscow Mountain, Idaho

Figure 13 Trillium ovatum showing the condition of the stigmas and the chloropetaloid sepals, H W & M T Crowley, Apr 1928, five miles south west of Deer Park, Washington

Figure 13a Showing the sagittate stamen.

EXPLANATION OF NUMBERS

Number 14 Trillium ovatum, Rocelia Palmer 239, May 26, 1928, Moscow Mountain, Idaho

Number 15 Trillium ovatum, Rocelia Palmer 240, May 26, 1928, Moscow Mountain, Idaho

Number 16. Trillium ovatum, J B Flett, May 21, 1916, Tahoma Creek, Washington.

Number 17 Trillium ovatum, Rocelia Palmer 231, May 6, 1928, Moscow Mountain, Idaho

Number 18 Trillium ovatum, Rocelia Palmer 236, May 26, 1928, Moscow Mountain, Idaho

Number 19 Trillium ovatum, Regina Cooper, May 13, 1928, Moscow Mountain, Idaho.

Number 20 Trillium ovatum, Rocelia Palmer 237, May 26, 1928, Moscow Mountain, Idaho

Number 21 Trillium petiolatum, B. Hunter, Apr 23, 1903, Hatwai Creek, Idaho

Number 22 Trillium petiolatum, George A Garmo 10, May 5, 1929, Pullman, Washington.

Department of Botany,
State College of Washington.

ERIOGONUM COMPOSITUM AND ITS VARIATIONS[1]

HAROLD ST. JOHN AND FRED A. WARREN

(Received for publication March 20, 1929)

In an attempt to identify some collections of *Eriogonum* from Mt Rainier and from the vicinity of Blewett Pass, Washington, it was found that the material of *Eriogonum compositum* needed to be restudied. Some of the plants of *E. compositum* had lanceolate leaves, while others had small ovate leaves, and still others had glabrous or pubescent scapes with the leaves strongly cordate.

E. compositum was first found by David Douglas along the Columbia River either in 1825 or 1826. There is no convincing evidence in his journals as to just where he collected his specimens. This plant is primarily of the Upper Sonoran life zone, though some of its variants are found up to 6000 ft. in the Hudsonian life zone on Mt. Rainier. It prefers open, warm, rocky or gravelly hillsides.

Bentham in De Candolle's Prodromus 14: 12, 1856, published a variety *leianthum*, distinguishable only by having a smooth involucre. One of the two collections cited by Bentham as the var. *leianthum*, Geyer 470, in the Kew Herbarium, shows some woolly pubescence at the tips of the involucres. Since one of the two collections originally cited by Bentham is not typical and as the writers do not find that the character of smooth involucre separates the specimens into natural groups, the var. *leianthum* is here reduced to synonomy. The writers are indebted to Dr. A. W. Hill of the Kew Gardens for assistance in comparing some specimens from the State College of Washington Herbarium with the types of Douglas and Bentham, which are deposited at the Kew Gardens.

The writers are also indebted to the curators of the following herbaria for the loan of valuable specimens. The abbreviations for the various herbaria consulted are as follows:

(O) University of Oregon, Eugene, Oregon.
(S) Dudley Herbarium, Stanford University, California.
(UC) University of California, Berkeley, California.

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[1] Contribution from the Department of Botany, State College of Washington, No 21.

(WSC) State College of Washington, Pullman, Washington.
(WU) Willamette University, Salem, Oregon.

The writers have found variability to a slight degree in the flowers and to a larger degree in the leaf outlines. The following key presents the characters that separate the varieties from the species:

Leaves broadly sagittate or deltoid with a cordate base, or ovate,
  Leaves all or some cordate at base, 3-7 cm. long,
    Scapes glabrous, flowers white or yellow,
      1. *E. compositum.*
    Scapes pilose, lanate, or sparingly so, flowers white,
      2. var. *pilicaulis.*
  Leaves ovate, 1.5-3.5 cm. long, flowers white,
      3. var. *simplex.*
Leaves lanceolate, cuneate or occasionally subcordate at base.
      4. var. *lancifolium*

1 ERIOGONUM COMPOSITUM Dougl., Bentham Trans. Linn. Soc. London, 17: 410, 1837; *E. compositum*, var. *leianthum* Bentham in DC. Prodr. 14: 12, 1856. The plant is an inhabitant of the Upper Sonoran and Arid Transition life zones of Washington, Idaho, Oregon and California. The following specimens of *E. compositum* have been examined.

WASHINGTON Palouse Falls, *St John & Pickett* 6197 (WSC); Robinson Fork, Touchet River, *St John, Davison & Scheibe* 6976 (WSC); between Ellensburg and Wenatchee, *Whited* 726 (WSC), North Yakima, *Steinweg* (WSC); Rock Lake, *Beattie & Lawrence* 2394 (WSC), North Yakima, *Griffith & Cotton* (WSC), Clark Springs, *Kreager* 94 (WSC); Naches River, *Ihrig* (WSC); Almota Canyon, *St John* 3369 (WSC); Spokane, *Henderson* (WSC); Wenatchee, *Vasey* 113 (WSC); Ellensburg, *Whited* 560 (WSC), Junction of Wilson and Crab Creeks, *Sandberg & Leiberg* 289 (WSC, UC); Wawawai, *Piper* in 1883 (WSC), Salmon River, Blue Mts, *Horner* 431 (UC), Columbia River W Klickitat Co., *Suksdorf* in 1881 (UC), Spokane County, *J B L[eiberg]* 107 (UC), Yakima, *Tweedy* Aug 1882 (S); Yakima Region, *Brandegee* 1882 (UC).

IDAHO Lewiston, *Heller* 3213 (UC, S); Clearwater River, *Sandberg, MacDougal & Heller* 269 (S); Kootenai County, *Leiberg* 190 (O).

OREGON. Fossil, *Leiberg* 123 (O, UC); Kimberly, *Henderson* 5133 (O), Paddys Creek, Wallowa Mts, *Cusick* 2219 (O, UC, WSC); Pilot Rock, *Cusick* 3438 (O); Barnhart, *Henderson* in 1886 (O); Tygh Valley, *Gorman* 7616 (O); Sisters, *Peck* 4307 (WU); Des Chutes River, *Sherwood* 342 (WU); Hood River, *Peck* 1631 (WU); Woodville, *Peck* 1630 (WU); Kamela, *Peck* 4309 (WU); Horse Creek Canyon, *Sheldon* 8244 (UC); Harper Ranch, Malheur

Valley, *Leiberg* 2232 (UC); Shake, Jackson Co, *Austin* July 1893 (UC); The Dalles, *Heller* 10075 (S); Pendleton, *Heller* 10174 (S); Pendleton, *Heller* (S); Sherar's Grade, Wasco Co., *Lawrence* 332 (S).

CALIFORNIA Blue Rock, Mendocino Co., *Rattan* June 1882 (S); Mendocino Co, *Rattan* June 1882 (S); Klamath Hills, *Butler* 1378 (S, UC); Mt. Sanhedrin, *Heller* 5913 (S); Klamath River, *Butler* 720 (UC); Klamath River, *Chandler* 1462 (UC), Whiskey Camp, Independence Creek, *Butler* 201 (UC); Callahan, *Alexander & Kellogg* 135 (UC); Hoopa Mt., *Davy & Blasdale* 5672 (UC); Pope Valley Grade near Calistoga, *Brandegee* June 1909 (UC).

2. ERIOGONUM COMPOSITUM Dougl., var. **pilicaulis** n. var.

The variety differs from the species by having the scapes pilose, lanate, or sparingly so, and the flowers white.

A specie differt in scapo parce piloso et floribus albis.

It is felt that the plant is not worthy of specific rank for the reason that the only difference from *E. compositum* is that the scapes are pubescent.

The large majority of the specimens cited below show clearly and definitely the characters enumerated. There are, however, a few specimens which in some degree depart from the others. The collections by *Shaw* from Mt. Rainier and *Peck's* 1634 from Grants Pass have their scapes nearly glabrous. If they were completely glabrous they could not be separated from *E. compositum,* even though they were collected in the high mountain country. The collection by *Thompson* 75 from Hood River has only a small amount of pubescence on the scape and some of the leaves are ovate, not cordate. Also *Peck's* 1632 from Hood River shows a few ovate leaves. These collections are, then, intermediate between var. *pilicaulis* and var. *simplex.*

The specimen *Peck* 9158 from Mt. Jefferson, in other particulars typical of the var. *pilicaulis,* has several of its leaves lanceolate. This character makes it intermediate to the var. *lancifolium.* These four specimens combined prevent the distinctions based on pubescence and leaf shape from being absolute and constant. Although these plant groups are conspicuous and have nearly distinct ranges, they cannot properly be considered species. They seem to be a series of varieties grouped around a parent species.

The varietal name *pilicaulis* is derived from two Latin words, *pilus* meaning a hair and *caulis* the stalk of a plant.

The material examined shows this to be a plant of the Hudsonian and the Humid Transition life zones of Washington and Oregon.

The material examined is as follows:

WASHINGTON Goat Mts., Pierce Co, 5500 ft., Aug 12, 1896, *Allen* 260 (WSC, UC, S) (type in Herb State College of Washington); St. Andrews Park, Mt. Rainier Nat'l Park, Pierce Co, 5500 ft., Sept. 9, 1919, *Shaw* (WSC), rocky places, 6000 ft, Mt. Rainier, Aug 1895, *Piper* 2127 (WSC); Goat Mts near Mt Rainier, Pierce Co, Sept. 20, 1893, *Allen* (WSC); South Mowich Glacier, Mt Rainier, Pierce Co, 5000 ft, Aug 1895, *Flett* 230 (WSC), dry rocky slopes near Ipsut Pass, Mt Rainier Nat'l Park, Pierce Co, 4700 ft, July 26, 1928, *Warren* 818 (WSC), rocks, Owyhigh, Mt Rainier Nat'l Park, 5500 ft, Aug 11, 1919, *Flett* 3059 (WSC), on talus slope, Cape Horn, Skamania Co, June 26, 1904, *M W G[orman]* 2034 (O), Yakima Region, Northern Transcontinental Survey, 1882, *Brandegee* (UC); steep rocky slopes, Beacon Rock, Skamania Co, June 21, 1919, *Gorman* 4609 (S)

OREGON · dry hill, Hood River, June 23, 1911, *Peck* 1632 (WU); Snow Camp, 4000-4250 ft, Currey Co, July 1916, *Thompson* 75 (S); Hood River, Hood River Co, June 21, 1903, *Sheldon* 12203 (S), cliffs along the Columbia River, Multnomah Co, June 26, 1911, *Peck* 1629 (WU); Grants Pass, Josephine Co, June 29, 1913, *Peck* 1634 (WU), sw slope of Mt Jefferson, 6000 ft, Linn and Marion Cos, Aug 14, 1919, *Peck* 9158 (WU); near Bohemia Mine and Jackass Ridge, Bohemia Mt, 5500 ft., Lane Co, Aug 9, 1927, *Henderson & Patterson* (O), Oregon City, Clackamas Co, Northern Transcontinental Survey, May 1885, *Brandegee* (UC)

3. ERIOGONUM COMPOSITUM Dougl., var. **simplex** (Wats ex Piper) comb. nov. *Eriogonum heracleoides* Dougl., var. *simplex* Watson ex Piper, Contr. U. S. Nat. Herb. 11: 238, 1906.

Prof C. V. Piper in his Flora of Washington treats this as a variety of *E. heracleoides,* a species characterized by having lanceolate or oblanceolate leaves and a whorl of leaves below the umbel. The plant here described does not have those characters and seems truly placed as a variety of *E. compositum.* Quoting from Piper, "Doctor Watson has labeled his specimen variety *simplex,* under which name the plant may be known."

The variety differs from the species by having ovate leaves which are 1.5-3.5 cm. long. It is believed that the character of size of the leaves is not sufficient to warrant it as other than of varietal rank. The material as cited below shows that it is an inhabitant of the Upper Sonoran life zone of eastern Washington.

WASHINGTON: White Bluffs, *Beattie* 3958 (WSC); Wenatchee, *Whited* 1149 (WSC); White Bluffs, *Beattie* 3968 (WSC); rocky bar of Columbia River, near Rock Island, *Whited* 1415 (WSC).

4. ERIOGONUM COMPOSITUM Dougl., var. **lancifolium** n. var.

Prof. Piper in his Flora of Washington considers this narrow leaved plant a part of *E. heracleoides.* Since this material does not show a whorl of leaves on the scape or the leaves densely tomentose on both sides, as in *E. heracleoides,* it should be considered a variety of *E. compositum* Prof. Piper in his book says, "It perhaps merits recognition as a subspecies."

This variety differs from the species in that the leaves are lanceolate, cuneate, and occasionally subcordate at the base. Also, the scapes are slightly pubescent and the flowers are white.

A specie differt in foliis lanceolatis cuneatis interdum subcordatis, scapis parce pubescentibus, floribus albis.

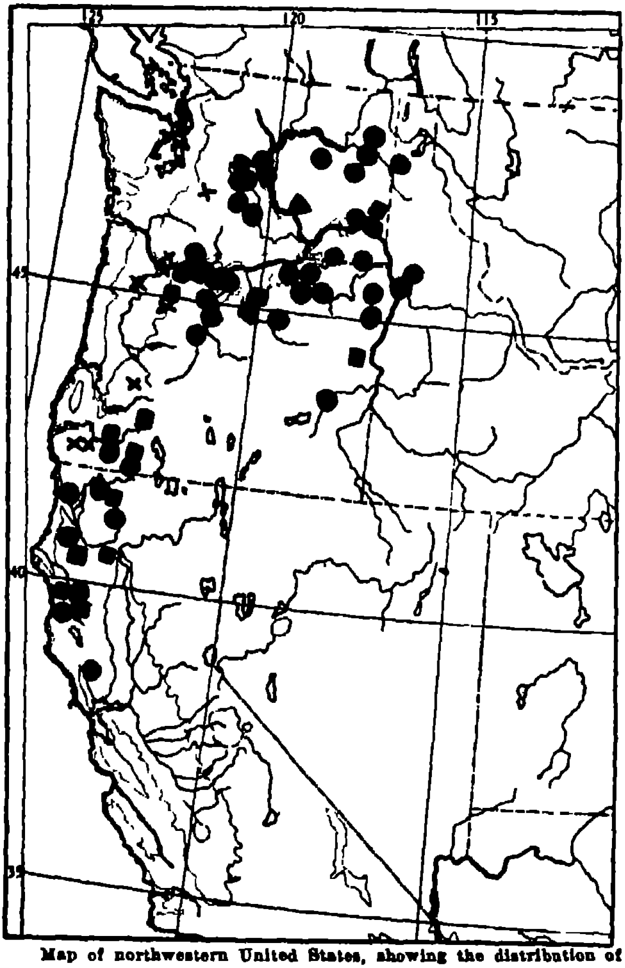
The name *lancifolium* is derived from two Latin words, *lancea* which means lance and *folium* a leaf.

The character of lanceolate leaves is hardly sufficient to cause the writers to consider this plant of higher than a varietal rank. This variety is rather wide-spread, as it is found in the Upper Sonoran and Arid Transition life zones of Washington, Oregon, and California. The specimens examined are as follows:

WASHINGTON dry serpentine soil, Old Blewett, Kittitas Co., June 10, 1927, *F A Warren* 539 (type in Herb State College of Washington); among rocks, Blewett Pass, Chelan-Kittitas Cos, June 7, 1924, *Warren* 333 (WSC); Mt Stuart, 4820 ft, Chelan Co, Aug 28, 1893, *Sandberg & Leiberg* 813 (WSC); Mt. Stuart, Chelan Co, July 1898, *Elmer* 1096 (WSC); Mt. Stuart, 8000 ft, Chelan Co, Aug 1893, *Sandberg & Leiberg* (WSC); Wenatchee, Chelan Co, May 17, 1896, *Whited* 92 (WSC); gravelly south sides of cliffs, Wawawai, Whitman Co., May 1897, *Elmer* 773 (WSC); Wenatchee Canyon No. 1, Chelan Co, May 13, 1900, *Whited* (WSC), 3800-7000 ft, Peshastin, Chelan Co, Aug 28, 1893, *Sandberg & Leiberg* 813 (UC).

OREGON in crevices of rock, The Dalles, Wasco Co, May 10, 1906, *Lunell* (S); dry slopes along Pine Creek, 7 miles above mouth, Wheeler Co, July 4, 1921, *Peck* 10044 (WU); Newton Creek, Mt Hood, Aug 6, 1927, *English* 804 (WSC); Grizzly Peak, Jackson Co., July 17, 1913, *Peck* 1633 (WU); Rogue-Umpqua Divide, 15 miles west of Crater Lake, Jackson Co, July 31, 1916, *Peck* 4308 (WU); Grants Pass, Josephine Co, June 1, 1912, *Prescott* (WU); near Grants Pass or Ashland, May 1, 1926, *Savage* (O); Huntington, Baker Co, May 16, 1905, *Holway* 51 (O)

CALIFORNIA · summit between Mad River and Pilot Creek, Humboldt Co., June 1883, *Rattan* (S); southern slopes of Mt Sanhedrin above sawmill, Lake Co, July 19, 1902, *Heller* 5913 (S); Scott River Valley, Siskiyou Co., June 15-July 15, 1899, *Gilbert* (UC), Hay Fork, Trinity Co, June 10, 1896, *Blasdale* (UC); on volcanic rocks near Long Valley, Mendocino Co., 1860-67, *Bolander*



Map of northwestern United States, showing the distribution of Eriogonum compositum and its varieties
Round spot, E compositum. Square spot, var. lancifolium.
Triangular spot, var simplex Cross, var pilicaulis

6567 (UC) ; Mt. Sanhedrin, 5000 ft, Lake Co., July 17, 1913, *Hall* 9509 (UC) ; Snow Mt, Lake Co, Aug 25, 1892, *K Brandegee* (UC) ; Snow Mt, Lake Co., 7000-8000 ft., July 1894, *Purpus* (UC), on barren rock walls of canyons, Dinsmore's Ranch, Valley of Van Duzen River, Humboldt Co., 2500 ft., June 22, 1913, *Tracey* 4262 (UC).

Department of Botany,
State College of Washington.

NEW AND NOTEWORTHY NORTHWESTERN PLANTS[1]

PART 3

HAROLD ST. JOHN

(Received for publication January 15, 1929)

SCIRPUS VALIDUS Vahl and S. OCCIDENTALIS (Wats.) Chase. Since the summer of 1913, when the writer made a botanical exploration of Sable Island, Nova Scotia, he has been observing the Bulrush or Tule. During the identification of the plants from this isolated island, it became obvious that the various contrasting characters definitely stated and clearly illustrated by Mrs. Chase[2] did not apply to the material collected These observations were published in 1921,[3] and there, following Prof. Fernald,[4] the older name *S. acutus* Muhl., was adopted for *S. occidentalis* (Wats.) Chase. In this study of the Sable Island plants, the writer stated, "*H. T. Gussow's* collection has well developed achenes only 2 mm. long, but the spikelets are borne for the most part in glomerules, so the plant is treated as of this species [*acutus*]. *H. St. John,* nos. 1,158 and 1,159 (H) do not have long spikelets, but the achenes are large, 2.5 mm. long, and the scales are long and overlapping. These specimens with a mingling of character of *S. validus* and of *S. acutus* raise the question as to the distinctness of these two species." Hence, at this station, the characters of length of spikelet, length of scale, and size of achene, varied, and were recombined in a manner different from those attributed to either *S. validus* or *S. acutus (occidentalis)*. As a matter of fact, the writer spent a long time studying all of the material in the Gray Herbarium, much of which had been studied and cited by Mrs. Chase, and found so many plants with intermediate characters that he became very doubtful of the specific distinctions.

During the summer of 1917, F. P. Metcalf worked with D. C. Mabbott on a survey of the marsh and aquatic plants of North Dakota. He also studied these two species of tule, and reported,[5] "*Scirpus occidentalis* (Watson) Chase and *Scirpus Validus* Vahl. The former is abundant throughout the state in marshes and sloughs, and the latter frequent but not clearly distinguishable from *S. occidentalis*, these two intergrade so completely that it is very doubtful if *S. occidentalis* should exist as a separate species; it is unfortunate that the majority of the specimens can be referred to the type *S. occidentalis* but *S. validus* having priority must stand. Under favorable conditions when *validus* was found in springy places, the soft, light green, thickened culm was apparent and distinguishable from the much harder olive-green culm of *S. occidentalis*, but here usually this character was too variable to be used for identifying the two species. Again, the broader achene and longer spikelet of *S. occidentalis* are considered valuable characters in distinguishing this species from *S. validus*. Numerous measurements and comparisons were made in the field with the result that all normal or extreme variations of both factors were found in a single patch that was all of the hard olive-green culm type. The character of the rays, whether flexuous or stiff, was subject to the same variation. In the east such extensive variation has not been observed. However, in North Dakota, until definite work has been done in growing these two species under different conditions of alkalinity it is still a question whether *S. occidentalis* is a valid species. Present evidence points in the opposite direction." It will be noted that his careful study indicated that the color, texture, and size of the culm, as well as the character of the rays, all varied too much and too irregularly to be of distinctive value.

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[1] Contribution from the Department of Botany, State College of Washington, No. 22.
[2] Agnes Chase, Rhodora 6: 65-71, pl 52-53, 1904.
[3] H. St. John, Proc. Boston Soc. Nat. Hist. 36: 65, 1921. ,
[4] M. L. Fernald, Rhodora 22: 56, 1920.

Recently the problem has been restudied with the help of the Herbarium of the State College of Washington, containing 29 sheets from Washington and Oregon and a few from other states. Contrary to the current interpretation, most of these specimens would fall on the side of *S. validus*. Only a few show the long spikelets, long scales, etc., of *S. acutus*. Here, as well as in the east, and in the middle west, the series of alleged distinguishing characters break down. The writer cannot convince himself that these are two species. There are several varying characters, and the extreme conditions are conspicuous, but the intermediates are numerous. The two ranges are so nearly coincident that on reconsideration of the question, there seems no reason for maintaining them even as minor variations. *S. occidentalis* (Wats.) Chase and *S. acutus* Muhl., are then referred to the synonomy of *S. validus* Vahl.

ERYTHRONIUM **idahoense** St. John & G. N. Jones, n. sp.

Corm deep seated, 12-20 cm. below the surface, ellipsoid or narrowly cylindric, brown coated with a slender rhizomatous process up one

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[5] Journ. Washington Acad. Sci 10. 193-194, 1920

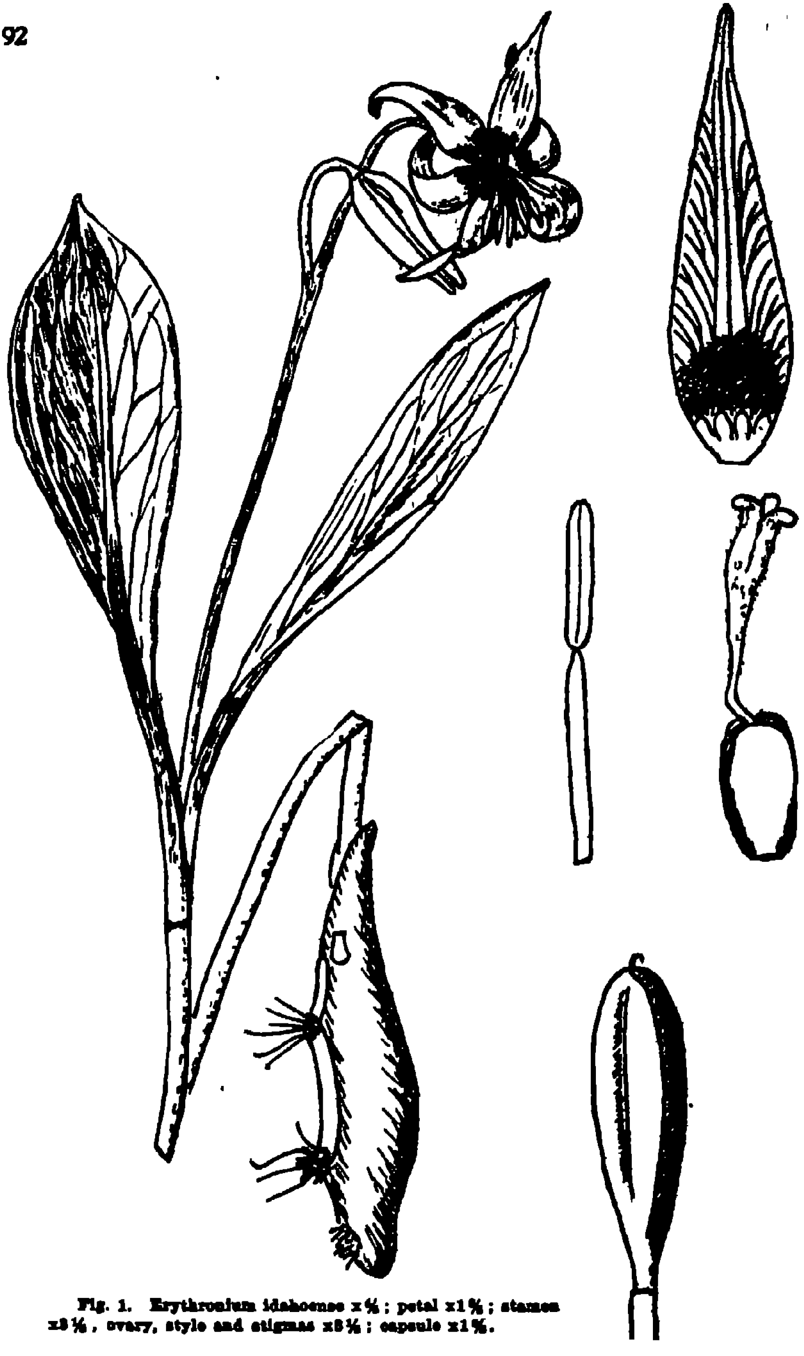

Fig. 1. Erythronium idahoense x⅔ ; petal x1⅔ ; stamen x3⅓ , ovary, style and stigmas x3⅓ ; capsule x1⅔.

PLATE 5

Erythronium idahoense living specimens of the type collection
—Photo by H St John

side; stem cylindric, the lower half subterranean, bearing near the middle one pair of opposite leaves, the upper half of the stem reddish, 8-25 cm. long; leaves green unequal oblanceolate with an acuminate cucullate tip, gradually tapering at the base, the larger blade at anthesis 7-13 cm. long, 2.5-4.5 cm. wide, the channeled petioles about half the length of the blade; buds terminal 1-3; flowers nodding; perianth segments greenish or creamy white, marked for the lower cm. with yellow within and with green or greenish-yellow without, 3-4.5 cm. long, 9-12 mm. wide, linear-lanceolate arcuate and recurved after anthesis; the petals slightly broader than the sepals and with four saccate infoldings at the base; stamens polymorphic, either with six short anthers 5-7 mm. long, or three short and three long·10-20 mm. long, these two conditions occurring in flowers on the same stem, or the flowers with all six of the stamens long, anthers white turning pale yellow after dehiscence, filaments filiform, 10-12 mm. long, usually equal, but sometimes three distinctly longer; ovary cylindric somewhat 3-sided; style slender, twisted at base, clavate at tip, stigmas 3 distinctly parted and recurved; pistil 14-20 mm. long at anthesis; fruit oblanceolate trigonous.

Foliis viridibus oblanceolatis cuneatis, floribus viridi-albis ad centrum flavo-coloratum, stigmatibus tripartitis recurvatis.

IDAHO cut-over pine woodland, Worley, Kootenai Co., March 21, 1926, *St John, English, Jones, Ransom* & *Ridout* 3719 (type in Herb State College of Washington), fruit from type locality, April 25, 1926, *St John, Gessell, Jones, Ridout* & *Woods* 4255; beyond Worley, April 17, 1926, *Nettie M. Cook;* sunny thicket, Lovell, Benewah Co, March 21, 1926, *St John, English, Jones, Ransom* & *Ridout* 3730; yellow pine woods, 5 miles e of Harvard, Latah Co, April 18, 1926, *Georgina Burke,* hills above lumber mill, Coeur d'Alene, Kootenai Co., May 24, 1923, *Nettie M Cook*

WASHINGTON Tiger, Pend Oreille Co, April 29, 1925, *E. E Hupp;* woods, Dry Canyon, Molybdenite Mt., Kaniksu National Forest, Pend Oreille Co., May 16, 1925, *St John, Pickett, Davison* & *Warren* 3741; also June 5, 1926, *W. P Hagemeyer,* Waverly, Spokane Co, April 19, 1928, *J. H Snyder*

In addition, the following specimens, though not in a condition to show all the characters, probably belong to this species. Washington: across Pend Oreille River from Dalkena, Pend Oreille Co., May 11, 1923, *R. Sprague* 107; Steptoe Butte, Whitman Co., April 6, 1906, *J. W. Hungate* This latter specimen is the type of *Erythronium grandiflorum candidum* Piper which was erroneously said to come from Cheney, Washington.[6] Oregon: low mountains, eastern Oregon, May

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[6] Piper & Beattie, Fl. S. E. Wash. 61, 1914.

12, 1898, *W. C. Cusick* 1869.

What was undoubtedly the same plant as that here described as *E. idahoense*, was first mentioned by Carl Purdy. He wrote[7] "I know of three forms of this species. (*E. grandiflorum*) * * * In the Pine woods of eastern Washington there is a form with pure white flowers with greenish yellow centers. In this the flowers are very large, and the narrow segments are closely recurved." Later in his article on "Western Erythronium",[8] he named it var. *albiflorum*. This name, of course, antedates *E grandiflorum candidum* of Piper. Mr. Purdy states, "It does not seem to me likely that any new species of Western Erythroniums will be discovered, for the forms are not local and the ground has been well covered." In spite of this dictum, we are venturing to describe the plant as a species The characters which we give and tabulate are to us abundantly convincing and adequate. The plant does not seem to be a mere color form. It is true that *E. idahoense* grows near *E grandiflorum*, but in no case have they been found growing together. The two ranges touch, but do not seem to overlap, and *E. idahoense* occurs further to the east towards the Bitterroot Mountains and at somewhat higher elevations. As a matter of fact, the species most similar to this new one is not *E. grandiflorum*, but *E. montanum* Wats. of the Cascade Mountains. *E. montanum*, however, has its larger leaves subcordate or rounded at base, ovate or ovate-lanceolate; the perianth segments milky white and colored with yellow and orange at the base, ovate-lanceolate, the greatest width at or near the middle and, in all specimens examined, the anthers are short, 3-5 mm long and are much exceeded by the pistil, and the plant grows at or above timberline in the high mountains—in the Hudsonian Zone. On the other hand, *E. idahoense* has its leaves oblanceolate and gradually tapering to a cuneate base, the perianth segments greenish or creamy white, marked near the base with yellow on the inner side and greenish on the outer, linear-lanceolate, the greatest width near the base, the anthers polymorphic, the short ones 5-7 mm. long, the long ones 10-20 mm. long, the latter exceeding the pistil, and the plant grows in the yellow pine woods—timbered Arid Transition. *E. parviflorum* (Wats.) Gooding has lanceolate leaves, the greatest width near the base, the perianth segments are a solid light yellow and the plant grows from the

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[7] Garden & Forest 10· no 478, 157, 1897

[8] Flora & Sylva, 250-256, 1904, Aug.

Canadian to the Hudsonian Zones. *E. idahoense*, on the other hand, has oblanceolate leaves, the greatest width near the tip, the perianth segements greenish-white, marked near the base with yellow within and greenish without, and the plant grows in the timbered Arid Transition Zone.

ERYTHRONIUM IDAHOENSE St. John & G. N. Jones, forma **tricolor** St. John, new forma.

Differing from the species only by having the anthers rose-pink and the ovary pinkish.

A specifie differt in antheris ovariisque roseis.

IDAHO yellow pine woods, 5 miles east of Harvard, Latah Co, April 18, 1926, *Georgina Burke* (type in Herb. State College of Washington)

This pink anthered form was found growing intermingled with the species, but was much less common It is possible that this new form represents a hybrid with *E. grandiflorum* Pursh. However, the anthers show abundant perfect pollen grains. In the absence of proof that the plant is a hybrid, it seem best to consider it a color form.

SMILACINA AMPLEXICAULIS Nutt, Journ Acad. Nat. Sci. Phila. 7: 58, 1834 Dr. Sereno Watson in his "Revision of the North American Liliaceae"[9] accepted this species as a western representative of the group containing the eastern species *S racemosa* (L) Desf. This view has been almost universally accepted, and the distinguishing characters between the two have scarcely been modified or amplified by later workers.

More recently other plants in this affinity have been described, such as *S. racemosa brachystyla* Henders[10] and *Vagnera brachypetala* Rydb[11] The generic name *Vagnera* is accepted by the adherents of the American Code, and most of the recognized species have been given combinations under that name.

While studying the collections of this group from the Pacific Northwest, the writer became suspicious of the validity of some of the above mentioned species. All the material in the Herbarium of the State College of Washington was carefully studied, and then through the kindness of Dr. F. W. Pennell, it was possible to study a represen-

[9] Proc Am Acad Arts & Sci 14 244 1879

[10] Bull Torrey Bot Club, 27 357, 1900

[11] Bull Torrey Bot Club, 28 268, 1901

tative series from the Academy of Natural Sciences of Philadelphia.

The short style which was used by Prof. Henderson to separate his *S racemosa brachystyla* was found to be undependable. Most of the plants having this character had very young and only partially developed flowers. There were, however, a number of mature plants showing distinctly shorter styles, but numerous others with intermediate lengths completely broke down any distinctions on this character.

Similarly, the writer has not been able to recognize as a distinct plant *V. brachypetala* Rydb.

Finally, the distinctions between *S racemosa* and *S. amplexicaulis* were considered. *S. racemosa* is alleged to have the leaves oblong-lanceolate, short petioled, and mostly narrowly acuminate, the style very short, the seed 4 mm in diameter, and its range is usually given from Nova Scotia to Georgia, Colorado, and British Columbia. *S amplexicaulis* is said to have the leaves ovate to ovate-lanceolate, mostly sessile and clasping at base, rarely acuminate, the style longer, the seed smaller, and its range from British Columbia to Alberta, California, and New Mexico. Each of these characters has been studied with a series of specimens The seed size and the style length are of no value Petioled or sessile leaved plants occur throughout both ranges, Plants with narrow acuminate leaves are to be found throughout the West, and broad merely acute leaved plants are occasional in the East. But for the last character, all those listed seem worthless. There is a hint of a difference in the leaf shape. In the far western states a distinctly larger proportion of plants have the broadly ovate acute leaves Still, these plants seem to grow side by side with the narrower leaved ones, and the difference seems to be within the normal range of variation between individuals of the same species. Prof. Henderson, who devoted much time to this problem, wrote, "And yet to one who has observed and studied these plants for years throughout Oregon, Washington, and Idaho, these apparently well marked differences disappear, and intergrading forms of every description can be found."

When so-called species intergrade as completely as these do, and have completely overlapping ranges, there seems no justification for maintaining them as distinct. As the writer has not seen the type specimens of all these plants, perhaps he should qualify his categorical statement, and merely assert that he has seen no evidence that any species of this group but *S. racemosa* (L.) Desf., occurs in the Pacific Northwest.

SMILACINA RACEMOSA (L.) Desf., var. **glabra** (Macbr.) comb. nov. *S. amplexicaulis* Nutt., var. *glabra* Macbr , Contr. Gray Herb. n.s. **56**: 18, 1918. This plant of the Sierras of California is distinguished by having its leaves and stems glabrous. It seems to be a very local variant, not appearing elsewhere in the broad range of the species.

CLAYTONIA LANCEOLATA Pursh, forma **chrysantha** (Greene) n. comb. *Claytonia chrysantha* Greene, Leaflets 2. 45, 1910.

The writer was interested to find in the Piper Herbarium a fragment of the type of this plant. The label includes the statements, "moist sandy slopes, Mt Baker, rare, flowers yellowish." This appeared in Greene's publication as "Moist sedgy southward slope of Mt. Baker, - - corolla - - deep orange."

After a careful comparison, the author can see no fundamental difference between this type material and *Claytonia lanceolata* Pursh. Were it not for Gorman's statement that the flowers were yellowish and Greene's that they were deep orange, there would seem no justification in maintaining the plant as distinct The dried specimens are discolored and do not now show this yellowish color or appear in any way different from that species *C lanceolata* is common in the upland areas in Washington and the adjacent states. The writer has often studied it in the field and collected it. The petals are white and usually have their veins distinctly pink Hence, plants with yellowish petals are somewhat different, but only worthy of rank as a forma

Dr Rydberg in his "Flora of the Rocky Mountains" takes up *C chrysantha* Greene to replace *C 'aurea* A Nels. This he keys as having the stem leaves linear or narrowly lanceolate, 1-ribbed or indistinctly 3-ribbed. The original material of *C chrysantha,* however, has the leaves distinctly 3-ribbed, and they are broadly lanceolate, just as they are in *C lanceolata* Because of the existence of an earlier homonym, Dr. Nelson has renamed the yellow-flowered plant of the Rocky Mountains *Claytonia flava* A. Nels.[12] There seems no doubt as to the distinctness of this from *C. lanceolata* and its yellow-flowered form

AQUILEGIA FORMOSA Fisch., var. **wawawensis** (Payson) n comb *A wawawensis* Payson, Contrib. U. S. Nat. Herb. **20**: 145, 1918. Dr. Payson based this new species on a single collection from the south bank of the Snake River, near Wawawai, Washington, May 26,

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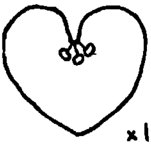
[12] Univ Wyo Publ Bot. 1· 143, 1926

1906, *Rex Hunt* 203. The type is in the U. S. National Herbarium, and there are two duplicate types in the Herbarium of the State College of Washington. The deep canyon of the Snake River, with its Upper Sonoran flora, its ruggedness and wildness, has long been a Mecca for the botanists of Pullman. Recently built auto roads have made it possible to explore many parts of it easily, and this has been done repeatedly by the local collectors. Until very recently there have been no subsequent collections of the *Aquilegia* Following directions from Mr. Hunt, the type locality was revisited on May 18, 1928 by G. N. Jones and Rocelia Palmer. It is actually opposite Truax and in Garfield County, some miles away from and in another county than Wawawai. Here the plants grow abundantly at the base of a perpendicular basalt cliff, in clefts wet from dripping water, above a talus slope The water has left a limy deposit on the surface of the rocks. The plants were observed closely and many sheets were collected, i e *Jones & Palmer* 1134

With this abundant well pressed material, as well as with fresh specimens, it has been possible to restudy the plant. The key characters depended on by Dr. Payson were, "Leaves membranous; sepals light red." It can be positively stated that the foliage is no more thin and membranous or the flowers no more light in color than the average plants of *A. formosa* from other regions. There is, however, one apparent difference besides the slightly smaller flowers The specimens all have the spurs very slender, but slightly swollen at tip and not asymmetric. *A formosa,* on the other hand, has the spurs sturdy, much swollen and asymmetric at tip No other characters could be detected. Then too, the local endemism has been destroyed by the discovery of the identical variation with slender spurs at Ellensburg, Washington, Aug. 2, 1927, *G N Jones* 1243. Since there remains but a single character to separate this plant, and as that is one of degree only, it is felt that it should be reduced to varietal rank.

ASTRAGALUS **violaceus** n sp Erect perennial; root woody stout erect bearing a multicipital crown; stems several erect freely branching throughout, glabrate and shiny whitish below, white appressed puberulent above, 4-7 dm. tall; basal and lower leaves reduced, bearing 5-7 leaflets, withered and gone by anthesis; leaves abundant, several times exceeding the internodes, odd-pinnate with 9-19 leaflets; stipules minute narrowly deltoid, partly greenish at first, scale-like; leaflets

oblanceolate, minutely cucullate chanelled apiculate, glabrous above, white appressed puberulent below and on the margins, slender petiolulate, 4-14 mm. long, 2-6 mm. wide; inflorescences several from the axils of the upper but not the uppermost nodes, loosely racemose and at fruiting time becoming from one and one-half to two times the length of the subtending leaf, 4-13-flowered, white appressed puberulent and lepidote; pedicels white appressed puberulent, slender, at first ascending, later divergent or curved downward, 3-8 mm. long; calyx white appressed puberulent and lepidote, campanulate, the tube slightly oblique at the throat 3 mm. long, the teeth unequal, the two upper broadly deltoid 1 mm. long, the three lower lanceolate 1.5 mm. long, buds dragon's blood red (R. Ridgway, Color Standards, Pl. XIII); flowers at anthesis a dull violet with many dark veins; banner with a short narrowly oblong claw 3 mm. long, the blade suborbicular emarginate sulcate, well reflexed and with a lighter spot near the base, 8 *mm. long*; wings about equaling the keel, the claw cuneate curved and sword-shaped 3 mm. long, the blade with a straight basal auricle 1.1 mm. long and the body oblong-elliptic, slightly asymmetric 7-8 mm. long, the keel gradually bent with the tip at 90 degrees with the lower margin, the veins less prominent, the claw unfolded, broadly oblong 4 mm. long, the blade folded and strongly upturned 8 mm. long, 4 mm. high when folded, ovary appressed sericeous, with a stipe exceeding the calyx in anthesis and in fruit twice the length of the calyx; pod papery oblong-elliptic, strongly inflated, not tapering to either end, the basal end somewhat cordate, the upper suture straight infolded, the lower not infolded, often acute, minutely and sparsely white appressed puberulent, more or less purplish maculate with inconspicuous minute spots, 1.5-2.7 cm. long, 1-1.6 cm. wide, 1-1.6 cm. high, obcordate in cross section; style upturned or reflexed, seeds numerous brown, kidney-shaped, 1.8-2.3 mm. long.



Cross section of fruit

Perennis, radice lignosa, caulibus erectis foliosis, foliis pinnatis, foliolis oblanceolatis supra glabris, floribus racemosis violaceis, leguminibus chartaceis inflatis.

WASHINGTON alkali spot, Sunnyside, Yakima Co., *P. A. Ruppert*, July 23, 1928, and Aug. 6, 1928 (type in Herb. State College of Washington); Two Rivers, Walla Walla Co., April 25, 1925, *T. Claude Baker*.

The specific name of this new species is derived from the Latin word *violaceus* for violet-colored.

Astragalus violaceus St. John is a member of the Section *Inflati* according to the revision by M. E. Jones, despite the fact that its dorsal suture is somewhat intruded. This group of species with the bladdery inflated 1-celled pods is treated by Dr. Rydberg and some others as the genus *Phaca* To the writer it seems both a more natural and a more practical classification to keep these species in the genus Astragalus.

This plant was sent in by Mr. Ruppert together with an introduced weed, *Centaurea repens* L. He thought both had appeared recently in his pasture by means of irrigation water The *Astragalus*, a tall stout perennial with woody roots, would seem to have been growing there for several years at least It was growing in spots white with alkali, such as are sparsely vegetated with native halophytic plants and seldom are invaded by introduced weeds. The writer believes *Astragalus violaceus* to be a native of the Yakima and Columbia valleys.

The closest relative of the new species is *Astragalus Hookerianus* (T. & G.) Gray. If differs in having: the stems decumbent, rarely 3 dm. long; the leaflets puberulent on both sides, the stipules lanceolate or deltoid, well developed and foliaceus at least above; the fruiting racemes shorter than or but little exceeding the subtending leaves; the pedicels stout, much shorter than the calyx; the calyx at least partly blackish puberulent; the corolla yellowish and usually purplish-tipped; and the pods 3-6 cm. long, 2-3 cm wide, tapering into the stipe, neither suture intruded, the cross section oblate-round In the Sierras of California there is also a var. *Whitneyi* (Gray) Jones Besides the characters of the species, this has the whole plant nearly smooth; the corolla purple, and the pods 2 cm. long. On the other hand, *A. violaceus* may be recognized by having: the stems erect, 4-7 dm. tall; the leaflets glabrous above, the stipules minute, scale-like, the fruiting racemes from one and one half to two times the length of the subtending leaves; the pedicels slender, exceeding the calyx; the calyx white puberulent; the corolla dull violet with darker veins; and the pod 2-2.7 cm. long, 1.6 cm. wide, not tapering to either end, the dorsal suture intruded, the cross section obcordate.

TRIFOLIUM FRAGIFERUM L. This clover with pink flowers and large subglobose heads of inflated calices can now be recorded from Washington. Mr. L. H. Smith has deposited in the Herbarium of the State College of Washington, specimens collected at Grandview. The species was abundant and well established in places saturated with water or white with alkali. *Puccinellia* and other halophytes were growing with it. It is reported to furnish valuable forage. Dr. A. J. Pieters informs the writer that this species is also well established in eastern Oregon: near Hermiston in Umatilla Co.

IMPATIENS AURELLA Rydb., Bull. Torr. Bot. Club, 28. 34. 1901. Dr. Rydberg first separated this species from the eastern *I. biflora* Walt, describing it from a single collection from Priest River, Idaho, 1900, *D. T MacDougal* 20. It was said to differ in its smaller unspotted flowers and its less pale leaves. Later he monographed the genus in the North American Flora, 25, pt. 2: 95, 1910. Here he continued the same interpretation, and described the petals as orange, but keyed the plant as having flowers golden-yellow. In the two editions of his Flora of the Rocky Mountains, the description was modified to, "posterior sepal orange," while the key character still remained, "flowers golden-yellow." In these latter treatments he allowed *I. biflora* also to occur in Idaho.

The genus does not grow in the vicinity of Pullman, and herbarium specimens of this group are notoriously unsatisfactory. Hence the writer made three special all-day trips to the Spokane region to study these plants in the field. Hundreds of plants were examined, careful notes taken, and a large number of specimens collected. Then, in 1926, part of this material was carefully compared with that in the Gray Herbarium. The conclusion reached was that *I. biflora* Walt. of the east, and *I. aurella* Rydb. of the northwest were different species. The latter can be distinguished by its narrower sac, tapering more gradually into the spur, and the flowers a clear or golden-yellow. This is doubtless the taxonomically typical material, and in many localities it is the only one occurring In others, plants with variously spotted flowers occur, sometimes rarely, or, at times, more commonly than the plain yellow true species. The yellow is always the ground color of the flower, but in the variants, crimson or reddish-brown color is present as spots or in parts as solid color masking out the yellow. These plants have no other distinguishing characters, and seem best treated as color forms. A similar and even more extensive series of color forms has been recognized in *I. biflora* Walt., by C. A. Weatherby.[13]

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[13] Rhodora 19: 115, 1917, and 21. 98, 1919

Impatiens aurella Rydb., forma **badia** n. f. Like the species having the flowers with a yellow ground color, but the spur of the posterior sepal spotted within with reddish brown, and the petals more strongly marked with the same color.

Floribus badio-maculosis.

Washington: shaded creek bank, Indian Canyon, s of Ft. George Wright, Spokane Co, Sept. 11, 1925, *H St John* 9210 (type in Herb State College of Washington).

Impatiens aurella Rydb., forma **coccinea** n. f. Resembling the species in having the flowers with a yellow ground color, but the sac of the posterior sepal spotted with crimson and the two lower petals solid crimson.

Floribus coccineo-maculosis.

Washington: wet bank of the Little Spokane River, Dartford, Spokane Co, Sept 27, 1924, *H St John & F A Warren* 6749 (type in Herb. State College of Washington); mossy river bank, Myers Falls, Stevens Co, Aug 19, 1902, *F O Kreager* 472.

British Columbia damp ground, Vernon, Aug 8, 1917, *J R Anderson*

Phlox **imminens** n. sp. Probably a perennial, but the basal portion not seen; stems probably woody at base; stems of the season slender herbaceous, finely puberulent but glabrate below, 2 dm. tall including the inflorescence, the internodes equaling or exceeding the leaves; leaves all opposite, spreading, linear-lanceolate, broadest at the somewhat clasping base, narrowly long acuminate, thick and coriaceous, the midrib and the nerves at the inrolled margins prominent, softly white pilose above towards the base, glabrous or glabrate below, the leaves of the inflorescence somewhat more and glandular pilose, leaves 4-5 cm long, 4 mm. wide; inflorescence a loose round-topped cyme, about 17-flowered, about 10 cm. wide and 12 cm. tall, densely glandular puberulent; pedicels slender, 4-18 mm. long; calyx narrowly cylindric, densely yellowish glandular short pilose, the ribs linear herbaceous 1-nerved, the intervals thin hyaline, the tube 5-7 mm. long, the calyx teeth deltoid-lanceolate, hyaline margined only at the base, 3 mm. long; corolla tube narrowly cylindric just equaling the calyx, glabrous without but softly white pilose within near the base; corolla lobes pink fading to blue, rhombic-suborbicular, rounded and obtuse or slightly emarginate at the apex, strongly bluish-black maculate at the base, not cuneate at the base, instead the margins much overlapping, the lobes

8-10 mm. long, 8-10 mm. broad; the upper stamen somewhat exserted; ovary elliptical with a solitary ovule, the ovary 1.7 mm. long; style glabrous stout 0.5 mm. long; stigmas linear and gradually acuminate 2 mm. long, hence the styles much shorter than the calyx or corolla tube but longer than the ovary.

Ramulis hornotinis 2 dm. altis, foliis omnibus oppositis anguste lineari-lanceolatis pilosis 4-5 cm longis 4 mm. latis, calycis cylindraceis glandulosis, dentibus dimidiis tubi, lobis corollæ roseis deinde cæruleis suborbiculatis, stylis ovario longioribus.

WASHINGTON· Columbia River Valley, Stevens Co, May 1911, *Mary B Gabby* 53 (type in Herb State College of Washington)

For a number of years this sheet has been shuffled back and forth from one species cover to another. The only logical course seems to be to describe the plant as new. It falls within the subsection *Meranthium,* and most closely resembles *P occidentalis* Durand. The latter may be recognized by having the stems glandular puberulent, the inflorescence glandular short pilose; the leaves acute, glandular-puberulent above and below especially towards the base; the calyx shorter than the corolla tube, the calyx teeth equaling the calyx tube; and the flowers white or pink, the lobes cuneate at base, obcordate, usually deeply emarginate, not spotted at base. *P. imminens* St. John may be distinguished by having the stems finely puberulent, glabrate below; the inflorescence glandular puberulent; the leaves long acuminate, softly white pilose above towards the base, glabrous or glabrate below, those of the inflorescence glandular pilose; the calyx equaling the corolla tube, the calyx teeth one half as long as the calyx tube; and the flowers pink, fading blue, the lobes rhombic-suborbicular, much overlapping at base, obtuse or very slightly emarginate, with a bluish-black spot at the base.

A. Brand in his monograph in the Pflanzenreich changed *P occidentalis* to *P. speciosa* Pursh, subsp. *eu-speciosa* Brand, var. *latifolia* (Hook.) Brand, forma *occidentalis* (Durand) Brand. *P. speciosa* Pursh has been studied by the aid of a photograph of the type specimen and abundant material from the type region. In Washington *P. speciosa* occurs in a narrow strip along the eastern border from the region of Spokane to Clarkston, while *P. occidentalis* ranges from Wenatchee to the Yakima Valley. Their ranges nowhere approach each other in this state, nor has any evidence been seen to indicate that the distinctive characters used to separate the two are inconstant. *P. occidentalis* Durand is here maintained as a good species.

Phlox speciosa Pursh, var. *elatior* Hook. might possibly be confused with this new species. No specimens of the former have been seen, but differences have been compiled from the descriptions of Hooker and of Gray. It may be distinguished by having the stem and leaves glabrous, and the lobes of the corolla obovate with a narrowed cuneate base.

The specific name of *P. imminens* is drawn from the Latin word *immineo* to project over, in allusion to the overlapping bases of the corolla lobes.

PHLOX **Suksdorfii** (Brand) n. comb. *P. speciosa* Pursh, subsp. *lignosa* Brand, var. *Suksdorfii* Brand, Pflanzenreich IV, fam. 250: 74, 1907. This plant with its perennial woody stems that exceed the shoots of the year, and its short oblong-lanceolate very coriaceous leaves seems fully and constantly distinct from *P. speciosa* Pursh. Its range barely touches that of the latter species. The type specimen was from Columbus, Klickitat County, Washington, *Suksdorf* 883. The following additional specimens have been examined by the writer.

WASHINGTON: Rock Island, (Kittitas Co) now in Chelan Co, July 12, 1893, *Sandberg & Leiberg* 443; Cascade Mts, Yakima Co., 1894, *Steinweg*, dry hillsides near Columbus, Klickitat Co, April 24, 1909, *Suksdorf* 6516.

HACKELIA **venusta** (Piper) n. comb. *Lappula venusta* Piper, Proc. Biol. Soc. Wash. 37: 93, 1924.

This is one of the group of perennial species that have been considered of the genus *Lappula*. Then, in 1923 Dr. I. M. Johnston[14] presented a study and revision of the group. As he clearly showed, the annuals are the true species of *Lappula* The perennials differ by characters of the inflorescence, the gynobase, the style and the nutlet. These are fundamental characters in the family. The right of these species to a generic status as *Hackelia* seems clear. *H. venusta* agrees with the other perennials in having this set of distinctive characters.

Lappula venusta was described from material collected, "Between Tumwater and Drury, Chelan County, Washington, May 18 and June 9, 1920, *I. C. Otis*, No. 895." Mr. Otis writes the author that the locality "was near the G. N. Snow Shed 1679.05 in Tumwater Canyon,

[14] Contrib Gray Herb n. s 68 43, 1923

growing on a pile of sand sifted down from the mountainside." The writer has revisited this region, but did not rediscover this species. However, it was noted that the mountainside was composed principally of magnesian schists with numerous outcrops of green serpentine. Localized on this area were the rare *Polystichum Lemmoni* Underw., *P. scopulinum* (D. C. Eaton) Maxon, *Lewisia Tweedyi* (Gray) Robins., and *Valeriana columbiana* Piper. It is probable that *Hackelia venusta* is also restricted to magnesian habitats.

Dr. Piper referred to it as a "very handsome species." The duplicate type material, which was kindly deposited by Mr. Otis in the Herbarium of the State College of Washington, shows that this description was by no means overdrawn. It is one of the lovliest species of the family that the writer has seen.

PLANTAGO MACROCARPA C. & S. This species has been known to range along the coast from the Aleutian Islands to British Columbia. Recently, mature and abundant material of this northern plant has been submitted by Mr. Otis. Hence, the range of the species can be extended southward to include Washington. The station is:

WASHINGTON sandy soil, shore of Ozette Lake, 25 ft elev, Clallam Co., June 28, 1927, *I C Otis* 1532.

DOWNINGIA ELEGANS (Dougl.) Torr., forma **rosea** n. f.

Floribus roseis. Differing from the species in having the corolla lavendar-pink, instead of the customary deep navy-blue. Both forms have a characteristic large white central 2-forked spot on the lower lip.

IDAHO: exsiccated mud ditch, 3 miles east of Princeton, Latah Co., July 1, 1928, *H. St John* 9627 (type in Herb State College of Washington)

In early and middle summer in eastern Washington and northern Idaho, it is a common sight to see the ditches previously wet and muddy but now dry and baked hard, brilliant with the deep blue of a carpet of the deep blue Lobelia-like flowers of *Downingia elegans*. The plants occur in great quantities, and little or no variation has been observed in them. Dr. W. L. Jepson in his revision of the California species[15] does not list any real color forms. At the locality near Princeton, Idaho, the normal blue-flowered species was very abundant. In a few of the patches the pink color form was present, making about 10% of the patch. Striking color forms like this seem to merit taxonomic recognition.

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[15] Madrono 1: 99, 1928.

The name of the new form is taken from the Latin adjective *roseus* meaning rose-colored.

ARTEMISIA VULGARIS L., subsp. **Michauxiana** (Besser) n. comb., var. **typica** n. var. *A. Michauxiana* Besser, in Hook. Fl. Bor. Am. **1**: 324, 1834. Drs. Hall and Clements present a convincing treatment[16] showing that what has been called *Artemisia discolor* Dougl. should be classified as a variant of *A. vulgaris*. Their choice of a name for the plant, however, does not seem to be in accord with any of the current sets of nomenclatorial rules, certainly not with the International Rules. They call the plant *A. vulgaris* L., subsp *discolor* (Dougl.) Hall & Clements, although indicating that *A discolor* was published in 1833 only as a synonym and had a valid publication only from 1836 *A Michauxiana* Besser, which they treat as *A. vulgaris discolor* (Dougl.) Hall & Clements, unnamed variant *A michauxiana* Besser, is an earlier valid name. Consequently, a new combination is here made for the subspecies. Besides these major trends called subspecies, there are others of lesser value. On pages 84 and 85 three of these are described by Hall & Clements. They seem to be common and noticeable extremes, such as are usually called varieties On this interpretation, the author ventures to make the necessary new combinations

A. VULGARIS L., subsp. MICHAUXIANA (Besser) St. John, var. **discolor** (Besser) n. comb. *A. discolor* Dougl. ex Besser, Bull. Soc. Nat. Mosc. **9**: 46, 1836.

A. VULGARIS L., subsp. MICHAUXIANA (Besser) St. John, var. **incompta** (Nutt) n. comb. *A incompta* Nutt., Trans. Am. Phil. Soc. II, **7**: 400, 1841.

BALSAMORHIZA CAREYANA Gray. This balsamroot is very common and over a large part of the Upper Sonoran Zone in Washington is the only one to be found. Near one of the writer's camps at the mouth of Moses Coulee, a single teratological individual was found. On all the heads of this plant the ray-flowers were tubular. By the cohesion of the margins a long slender tube was formed. The four lobes at the mouth were either erect or somewhat divergent. The collection has the following data:

[16] Carnegie Inst. Publ 326: 74, 1923

WASHINGTON dry sandy hillside. mouth of Moses Coulee, Douglas Co, April 12, 1925, *St. John, Pickett & Warren* 6926.

ERIGERON chelanensis n. sp. Perennial from a slender fusiform caudex; stems one or two in number, herbaceous, slightly puberulent above, glabrate below, evenly leafy, slender and assurgent; basal leaves numerous, elliptic to broadly spatulate, apiculate at apex, cuneate at base, hispidulous on the margins and sparingly so above and beneath, blades 2-3 cm. long, 1-1.5 cm. wide, shorter than the slender margined petioles; cauline leaves several, evenly distributed nearly to the summit, sessile, ovate-lanceolate to lanceolate, apiculate, sparingly pubescent with short capitate glandular hairs and a few hispidulous ones on the margin, 1.5-2 cm. long, 6-8 mm. broad, stems slender 1-2 dm tall, glandular puberulent above, sparingly so below, monocephalous; heads showy 2 5-3 cm. in diameter; involucre hemispheric; bracts in two series, glabrous or occasionally slightly pilose at base but becoming glabrate, linear-oblanceolate with an abruptly caudate acuminate tip, scarious margined and somewhat ciliate at the tip, 7-8 mm. long; rays 25-35, broad, pale lavendar when dry, probably pink when fresh, twice or more than twice the length of the bracts, ray flowers pistillate, the achenes short pilose cylindric, the pappus bristles about 16 barbellate yellow 3 mm. long, the broad corolla tube equaling the pappus, the ray 2.5 mm. broad toothed at the apex; disk flowers perfect, yellow, the ovary about 1 mm. long cylindric hispidulous, the pappus bristles about 14-16 barbellate yellow in one series 3 mm long, corolla tube glabrous 3.5 mm. long gradually widening to the apex.

Resembling and most closely related to *E. Leibergii* Piper of Mount Stuart. This species, however has: stems hispid, petioles broadly winged, bracts linear hispid, and the rays 20-25 in number 1 cm. long; while *E. chelanensis* has the stems slightly puberulent above, glabrate below, petioles slender narrowly winged, bracts linear-oblanceolate caudate glabrous or slightly pilose but becoming glabrate at base, rays 25-35 and 1.5-2 cm. long.

Perennis herbaceus, foliis radicalibus ellipticis spatulatisve, caulibus foliosis monocephalis, glabris glabratisve, bracteis lineari-oblanceolatis, ligulis 25-35.

WASHINGTON: Agnes Gorge, Agnes Creek, Chelan County, July 16, 1923, *H St John & L. Ridout* 3619 (type in Herb State College of Washington, Pullman, Wash.).

GRINDELIA **Paysonorum** St. John n. sp. Perennial from a large deep tap-root with a multicipital crown; stems several, simple to the inflorescence, 3-4 dm. high, smooth, pale greenish or largely suffused with reddish, terete or slightly angled below the nodes; basal leaves numerous, though often withered and gone at flowering time, linear-oblanceolate with a slender petiole 3-5 cm. long, the blade 4-10 cm. long, 1-2 cm. wide, serrate near the tip, glabrous but resinous-dotted; cauline leaves numerous large scarcely reduced below the inflorescence, the lower with a short slender petiole, the upper sessile with a broader auricled base, glabrous pale green, copiously resinous-dotted, oblanceolate to oblong-oblanceolate acute apiculate, entire or remotely serrate, 2-10 cm. long, 5-25 mm. wide; inflorescence a leafy cyme, the branches 1-flowered; heads 2-7, the involucre 10-12 mm. high, 1-2 cm. wide, the outer involucral bracts narrowly deltoid-lanceolate, the inner oblong-lanceolate, all with linear terete acicular pointed squarrose tips which are 1.5-3 mm. long, bracts resinous-dotted, becoming gummy all over; ray-flowers 15-26, 12-17 mm. long, the ray elliptic-oblong, 10 mm. long, 3 mm. wide, its pappus-bristles 3 mm. long; disc-flowers very numerous glabrous, corolla about 6 mm. long, achene glabrous brown striate, oblanceolate or oblong-oblanceolate, flattened or somewhat rhomboidal, more or less curved and asymmetrical, 4-5 mm. long, 1.5-2 mm. wide.

Perennis herbacea, caulibus glabris rubrescentibus 3-4 dm. altis, foliis basilaris petiolatis lineari-oblanceolatis glabris glanduloso-punctatis, foliis caulinis oblongo-oblanceolatis, involucris 10-12 mm. altis 10-20 mm. latis, squamis glutinosis lanceolatis in acumen filiforme recurvato-squarrosum productis, ligulis 10 mm. longis, pappo disci lævi contorti 3.5-4.5 mm. longo.

IDAHO: dry ground, 900 feet altitude, Lime Point, T 32 N, R 5 W, Nez Perce County, May 9, 1926, *H St John* 4361 (type in Herb. State College of Washington); Lime Point, *B Ransom & L Ridout* 158; dry basalt walls of Snake River Canyon, alt 4800 feet, s of Zaza, Nez Perce Co., Oct. 9, 1927, *H. St John* 9103; dry clay slope, alt. 4500 ft, Salmon, Lemhi Co, July 3, 1920, *Edwin B. Payson & Lois B Payson* 1883 (Herb. Gray).

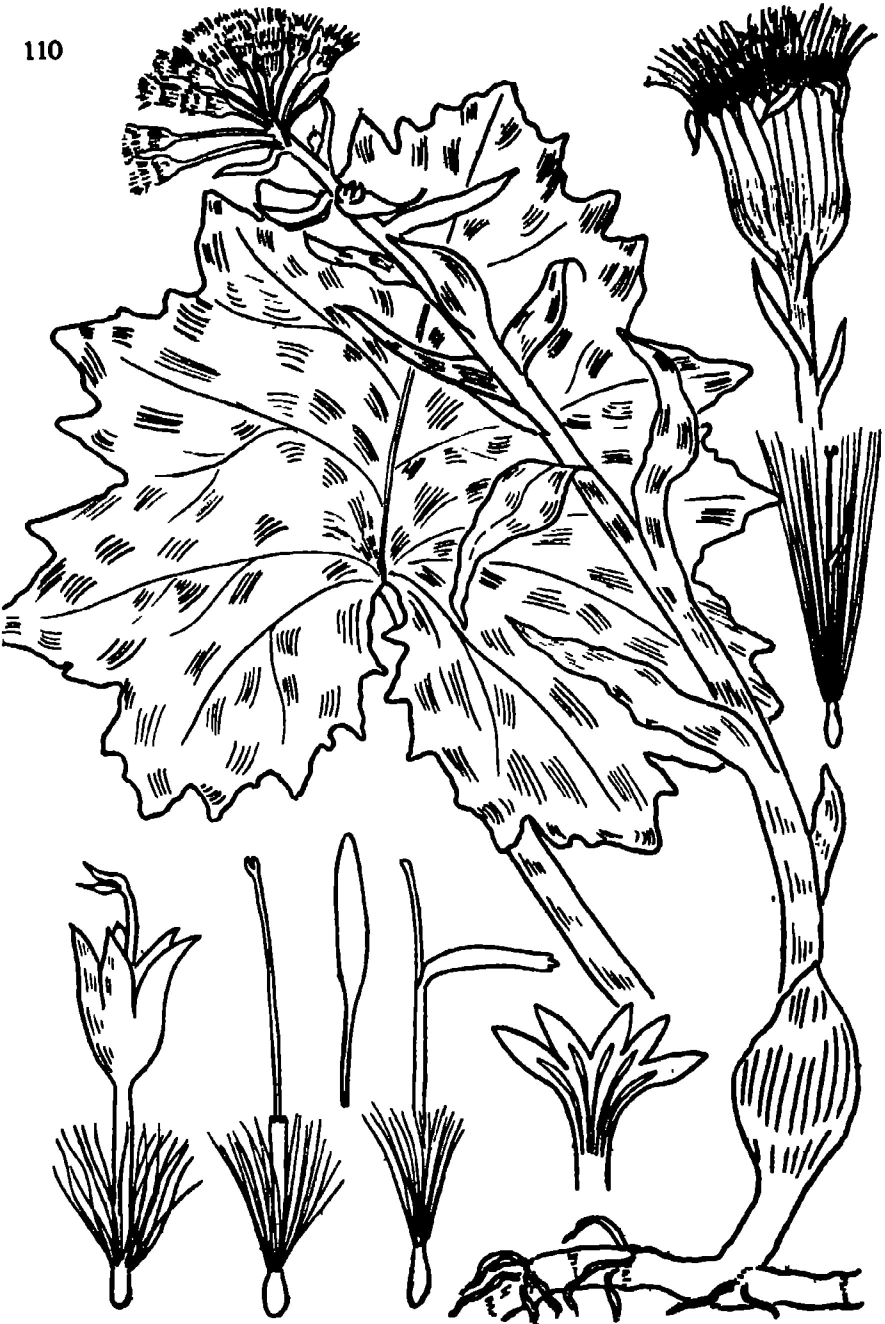
It is a pleasure to name this new species for Dr. and Mrs. Payson, in recognition of their splendid work in botany.

The new species *G. Paysonorum* is most closely related to *G. integerrima* Rydb., which was described from material collected in Bonner County in northern Idaho. *G. Paysonorum* may be distinguished by having the cauline leaves 4-10 cm. long, the involucre 10-12 mm. high, the bracts with slender squarrose tips 1.5-3 mm. long the ligules 12-17 mm. long with blades 10 mm. long, the pappus bristles 3.5-4.5 mm. long. *G. integerrima* may be separated by having the leaves 2-4 cm. long, the involucre about 7 mm. high, the bracts with very short squarrose tips, the ligules 6-7 mm. long, and the pappus bristles 3 mm. long.

LACTUCA MURALIS Fres. This European and African plant, previously recorded from British Columbia, can now be listed as an adventive in Washington. The following collection has been examined:

WASHINGTON · wet beach, Cattle Point, San Juan Island, June 24, 1923, *M E Peck* 12678a.

PETASITES **Warrenii** n. sp. Perennial, with a stout white horizontal rootstock that roots abundantly at each node, growing buried in the mud or in the mud under shallow water; scape about 3 dm. tall at anthesis, 5-6 dm. tall in fruit, floccose lanate, scaly throughout with numerous large subfoliaceous bracts, these green and glabrate above, white floccose lanate below, lanceolate sessile somewhat clasping, 5-9 cm. long, 5-20 mm broad; leaves all basal, arising from separate buds on the branching rhizome; petioles lanate, 5-15 cm long at anthesis, 2-4 dm. long at maturity; leaf blades sparingly lanate above, nearly glabrate, white and densely floccose lanate beneath, broadly ovate in outline, shallowly 11-15-lobed, the smaller lobes often entire, all deltoid acute or caudate, the larger with several large deltoid teeth, the blade 13-25 cm. long, 13-27 cm. broad; no hermaphrodite plants found among the many examined; inflorescence primarily pistillate, a short compact and almost cymose raceme; pedicels lanate few bracted slender becoming 1-4 cm. long; heads narrowly campanulate; bracts 15-22, lanate at base glabrous above, narrowly linear-lanceolate 3-nerved hyaline on the margin and with a more or less purplish tip, otherwise green, 4-6 mm. long and in fruit up to 10 mm. long; receptacle flat; ray flowers about 23 in number, the tube narrow 4 m.. long, ligules white divergent linear commonly truncate and 3-toothed but occasionally 1-toothed and acute 1.2-2 mm. long and 0.3 mm. wide; intermediate flowers, i. e. ray flowers, with shorter broader corolla tube and no ligule, numerous, about 82 in number, the corolla tube cylindrical 5-toothed, about 2 mm long; disc flowers about 3 in number, the tube cylindrical 2.8 mm. long, the throat broadly campanulate, dis-



—Drawn by Edith Hardin

tinctly 2-lipped, 2.1 mm. long, the lobes ovate-lanceolate acute; pappus white copious, 2 mm. long at anthesis, 6-10 mm. long in fruit, achenes glabrous.

Perennis, foliis radicalibus ovatis 11-15-lobatis lanatis, 13-25 cm. longis, 13-27 cm. latis, scapis bracteatis lanatis, squamis 15-22 lineari-lanceolatis 4-6 mm. longis, ligulis albis lineariis 1.2-2 mm. longis, floribus intermediis 82, floribus disci 3.

WASHINGTON swampy ground near Swauk Creek, Kittitas Co, April 30, 1926, *F A Warren* 380; rooting in mud in shallow ditch; Liberty, Kittitas Co, April 7, 1927, *St John, English, Jones & Mullen* 8106; wet soil along Swauk Creek, near Liberty, Kittitas Co., June 11, 1927, *F A Warren* 542 (type in Herb State College of Washington)

This striking plant is named for the collector who first found it at the foot of the highway leading over Blewett Pass across the Wenatchee Mountains. The spring of 1927 was very late, and when the writer and his party visited the locality, two feet of snow were found on the level. After a long search some of the plants were found just appearing above the water in a shallow ditch. Some of these were pressed, and others brought back to the State College, where they were grown in shallow pans in the green house. The plants grew nicely and provided excellent foliage and flowering material. From this fresh material the accompanying line drawing was made by Miss Edith Hardin.

It was obvious from the first that this plant was of a species not previously known in the state of Washington. It was not so easy to determine whether or not it was a species previously described from elsewhere. A number of the American species have been founded on very inadequate material and published with brief and unsatisfactory descriptions. Dr. I. M. Johnston of the Gray Herbarium, Dr. S. F. Blake of the U. S. Dept of Agriculture, and Dr. P. A Rydberg of the N. Y. Botanical Garden have kindly assisted the writer in making comparisons with the older species.

The recent appearance of a treatment of this genus by Dr. P. A. Rydberg in the North American Flora has simplified the problem. It is evident that this plant from the Wenatchee Mountains cannot be confused with any known species. It is probably closest to *P. hyperboreus* Rydb., which may be distinguished by having the leaf blades more lobed and with rounded sinuses, 5-10 cm. long, 7-13 cm. broad; the involucral bracts about 15 in number; the pistillate heads with the tube of the ray flowers 6 mm. long, the ligule 2-3 mm. long, 0.5 mm. wide; the pappus at anthesis 3-5 mm. long and in fruit 15-18 mm. long. *P. Warrenii* St. John has, on the other hand, the leaf blades 13-25 cm. long, 13-27 cm. broad; the involucral bracts 15-22; the pistillate heads with the tube of the ray flowers 4 mm. long, the ligule 1.2-2 mm. long, 0.3 mm. wide; the pappus at anthesis 2 mm. long and in fruit 4-7 mm. long.

Department of Botany,
State College of Washington.

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RESEARCH STUDIES
OF THE
STATE COLLEGE OF WASHINGTON

THE MOSS FLORA OF SOUTHEASTERN WASHINGTON AND ADJACENT IDAHO

PART 1

GEORGE NEVILLE JONES

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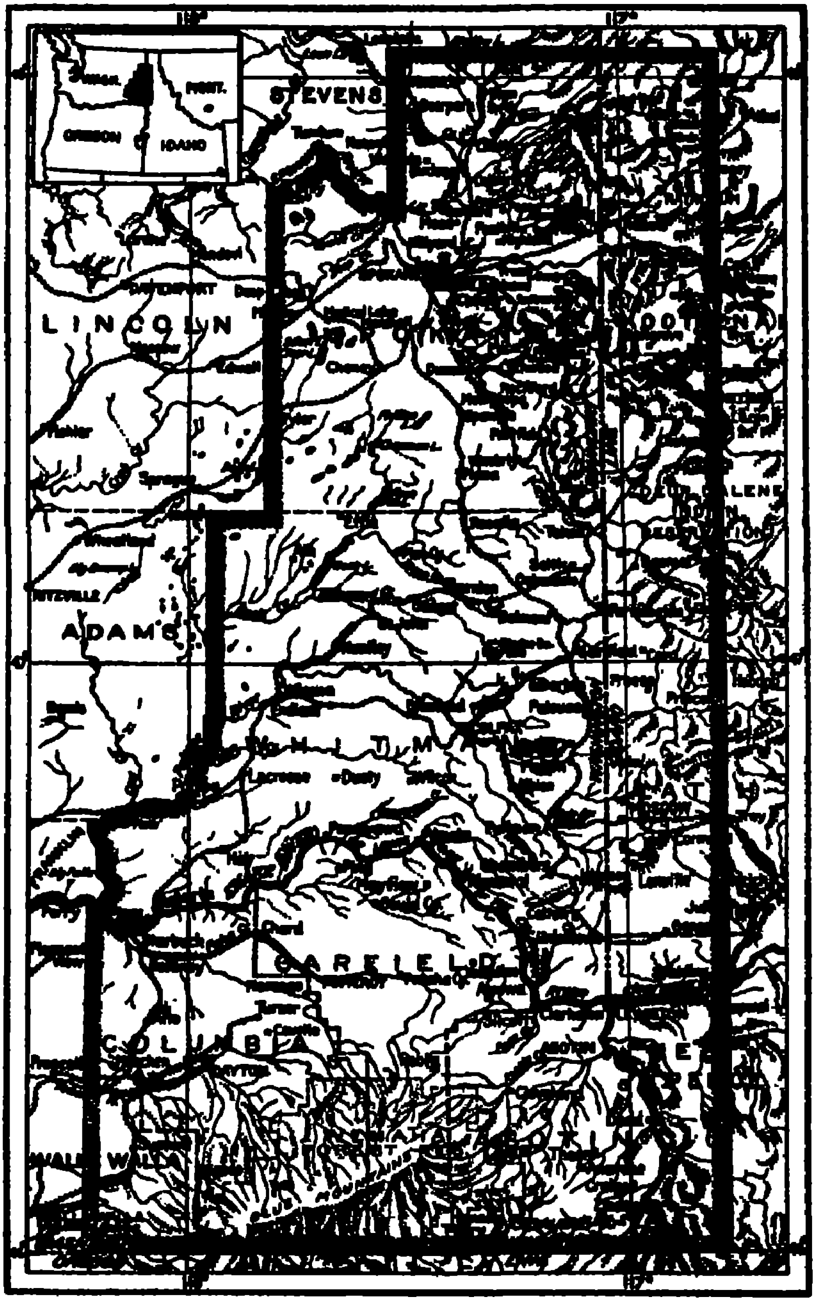

Map of Southeastern Washington and Adjacent Idaho

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THE MOSS FLORA OF SOUTHEASTERN WASHINGTON AND ADJACENT IDAHO*

GEORGE NEVILLE JONES

(Received for publication May 7, 1929)

INTRODUCTION

The aim of the present treatment is to give keys and brief descriptions of the mosses found in southeastern Washington and adjacent Idaho for the benefit of the general student. It will, without doubt, be found useful over a much wider area than that which it specifically covers.

The boundaries of the area considered are largely artificial, being essentially those of the area of the *Flora of Southeastern Washington and Adjacent Idaho* by Charles V. Piper and R. Kent Beattie, 1914, covering "Spokane, Whitman, Asotin, Garfield, Columbia and part of Walla Walla Counties, Washington, and the western portions of Kootenai, Latah, and Nez Perce Counties, Idaho." For present purposes, however, this rather homogeneous floral area has been extended in the southwestern corner to include a part of the Grand Canyon of the Snake River to a point about ninety miles south of Lewiston, Idaho.

At the present time precise specific, or even generic, differentiation of the mosses in western United States is often difficult to accomplish. No moss flora of the Pacific Coast has yet been published and information about the local plants is scattered through many books and technical papers, and frequently in another language. There is a great scarcity of monographic work to co-ordinate the isolated descriptions of proposed new species. Although no attempt has been made in this paper to treat the subject exhaustively, it is believed that with the use of it the student will be enabled to arrive at a better understanding of our interesting but much neglected moss flora. While not complete, it embodies all that is known up to the present time regarding the moss flora of this region, its distribution and occurrence. Much remains to be done taxonomically and ecologically.

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* Contribution No. 24 from the Botany Department of the State College of Washington.

Only the Bryales are included here. As far as is known, no member of the Sphagnales occurs in the area although several species are known from the adjacent parts of north Idaho. The Anthocerotales, Jungermanniales and Marchantiales of northwestern United States have been recently treated by Clark and Frye.[1] Considerable effort has been expended on the keys, an analytical key to the families, an artificial key to the genera and keys to the species in the genera. For the purpose of convenience a key to the gymnostomous genera has been included. The family key is intended to give some idea of the probable phylogeny. The key to the genera is based on leaf characters, is wholly artificial and is not intended to indicate natural relationships; but it is expected that it will prove useful in the actual determination of specimens, since many species are frequently sterile.

Most of the descriptions of species have been made from specimens collected in the region, and an attempt has been made to present an account of the plants as they actually exist rather than a compilation from existing literature. However, a great many authorities have been consulted, and free use has been made of every available source of information that has been found helpful. On page 190 is a list of the principal publications that contain references to the local flora.

Perhaps no system of arrangement of the families of mosses which best represents their phylogenetic relationships has yet been devised. The arrangement by V. F. Brotherus in the second edition of *Die Natürlichen Pflanzenfamilien* appears to be a distinct improvement over that of the first edition, nevertheless it leaves much to be desired. It seems better, therefore, to adhere to a more conservative arrangement until an obviously better system is proposed. The sequence of the families herein followed is essentially that of Dixon and of Grout. "This arrangement places those families with perfectly developed hypno-bryaceous peristomes close together, and places the primitive or degenerative acrocarpous peristomes *before* this group, and the pleurocarpous mosses with the same type of peristome *later*, as the best way to show relationships in a linear arrangement."[2]

[1] Pub. Pug. Sound Biol. Sta. 6: 1-194, 1928.

[2] Grout, Bryologist 31: 60, 1928.

The treatment of genera and species has been carried out along somewhat conservative lines. Only genera that have marked characters have been treated as such; the tendency to segregate genera until they are practically reduced to the level of species has not been followed. Similarly, several genera that recently have been raised to family rank are herein accorded merely generic status. Thus, for example, Ptychomitrium and Hedwigia are included in the Grimmiaceæ.

It is interesting to note that scarcely more than one-fourth of our local species are endemic to the United States, and, with few exceptions, this number consists of species which are found only on the Pacific Coast.

In the matter of nomenclature, the principle of priority has been followed throughout, and the rules adopted by the International Botanical Congress held at Brussels in 1910 have been adhered to. Thus Hedwig's *Species Muscorum,* 1801, is the starting point of nomenclature in the Bryales. Pre-Hedwigian authorities have been inserted in brackets.

A closer examination of the region is sure to reward the botanist by finding forms which never have been observed here before, if indeed they are not new to science. Especially is this likely to be true along the very artificial eastern boundary. Many species not included herein actually have been reported from northern Idaho, but have been excluded partly because of the necessity of drawing a line somewhere, and also partly because of the lack of first-hand knowledge concerning them.

HABITATS

The principal factors controlling the distribution of mosses are climate, exposure, substratum, and the general character of the surrounding vegetation. While some mosses are somewhat erratic in their choice of habitats and may be found occasionally in unusual places, most genera and species have their peculiar preferences of substrata. As a general rule, moss communities may be classified into a few groups. These groups should not, however, be regarded too exactly. The flora of this region may be classified as follows:

SAXICOLES are plants which occur on rocks. Where the surface of the rock has been decomposed by lichens, and as a result of weathering, crevices and pores appear, small quantities of soil and humus

ARID TRANSITION ZONE. For the most part, this zone consists of a great rolling, treeless plateau, varying in elevation from about two thousand to two thousand five hundred feet, and occupying a strip between the Upper Sonoran on the west and the Canadian on the east. Formerly this plateau was covered with bunchgrass *(Agropyron spicatum)*, but it is now a wheat growing area; almost the only moss-habitats left intact are to be found along the road- and creek-sides. That part drained by the Palouse River is the well-known "Palouse Country."[8] Some of the characteristic mosses are as follows:

Ceratodon purpureus
Tortula ruralis
Encalypta vulgaris
Funaria hygrometrica
Grimmia montana
Orthotrichum affine, var. *fastigiatum*
Brachythecium albicans
Amblystegium serpens
Eurhynchium pulchellum

CANADIAN AND HUDSONIAN ZONES. Near the Washington-Idaho boundary there is a series of low quartzitic or granitic mountains or buttes ranging from three thousand five hundred to five thousand feet in height. In extreme southeastern Washington and adjoining Oregon are the Blue Mountains, composed largely of basalt and rising over six thousand feet.

Up to an altitude of five thousand feet these buttes and mountains are covered, on their moist north slopes at least, with a predominantly coniferous woodland composed of yellow pine *(Pinus ponderosa)*, Douglas fir *(Pseudotsuga taxifolia)*, white fir *(Abies grandis)*, western larch *(Larix occidentalis)*, and the western cedar *(Thuja plicata)*. In moist situations at higher altitudes, often at the borders of damp alder *(Alnus sinuata)* thickets, the Englemann spruce *(Picea Engelmanni)* may be found.

It is in these moist woods that the moss vegetation of this area reaches its best development. On soil in open places, *Polytrichum juniperinum* and *Timmia austriaca* are often common. *Ceratodon purpureus* and *Funaria hygrometrica* are in evidence nearly everywhere on the ground in open woodlands. The latter is one of the first mosses to appear after a forest fire, when it is often associated with *Marchantia polymorpha*. Together they frequently form a turf which may extend over a considerable area. In similar situations, especially where the soil is moist, *Catharinaea undulata, Bryum lucidum* and several species of *Mnium* may be found. On the decaying logs and stumps in the damp forest, *Dicranum* occurs. On the trunks and branches of living trees and bushes, such as Sambucus, Prunus, Salix or Cratægus, *Orthotrichum affine* var. *fastigiatum* is not uncommon. *Philonotis fontana* occurs in loose yellowish green tufts very extensively in the mountain swamps. On rocks in streams, the typical hydrophytic mosses are *Fontinalis neo-mexicana, Brachythecium illecebrum, B rivulare* and *Drepanocladus uncinatus*. *Neckera Menziesii* is a locally abundant moss that grows in robust, brownish green, spreading tufts on rocks and tree trunks in moist woods, particularly in the neighborhood of streams. In the denser coniferous woods, two species of Hylocomium, *H. splendens* and *H. robustum,* are not uncommon. The latter species is more frequently found in this area. On rocks, soil, and bases of trees and shrubs the following mosses are representative:

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[8] Probably derived from the word Pah-loots (gooseberry), which is applied by the Nez Perce Indians to the Palouse River at its mouth.—T. C. Elliot, Wash. Hist. Quarterly 18, pt. 4: 8, 1927.

Camptothecium megaptilum
Amblystegium serpens
Claopodium crispifolium
Eurhynchium pulchellum
E. oreganum
Pseudoleskea atrovirens
Pterigynandrum filiforme
Brachythecium lamprochryseum
B. velutinum
B. Nelsoni
B. collinum, var. *idahense*
B. albicans, var. *occidentale*

Above five thousand feet the trees are few and dwarfed and the moss flora is correspondingly less abundant. On the dry open grassy slopes such shrubs as *Prunus emarginata, Rosa* sp., and *Symphoricarpos albus* are common. On these dry open slopes where grasses and other herbaceous plants form the predominant vegetation, mosses are scarce. There are no characteristic Hudsonian species in this area. *Grimmia calyptrata,* an Upper Sonoran species, which is relatively uncommon in the Arid Transition and practically non-existent in the Canadian Zone, usually occurs abundantly in round gray cushions with *Polytrichum piliferum* on exposed rocks at the higher levels. Another Grimmia, *G. ovata,* also may be found in this zone, particularly on quartzite or granite.

COLLECTORS

So far as is known, the earliest record of any moss collecting in eastern Washington is that of David Douglas in 1826 and 1831. He was a British botanist sent by the Royal Horticultural Society of London to collect plants in northwestern America. He collected in eastern Washington at or near the present sites of Spokane and Walla Walla, and in the Blue Mountains; also at the mouth of the Clearwater River at the present site of Lewiston, and in the Craig Mountains. The record of his moss collecting consists of a few notes in his Journal in which he mentions Hypnum, Polytrichum, Bartramia, and Bryum.

Dr. David Lyall, who was connected with the International Boundary Survey, is credited with a considerable number of moss specimens which he or another member of the party, John Buttle, collected in eastern Washington and adjacent Idaho in 1860. An account of these collections was published in 1865 by William Mitten in the Journal of the Linnean Society.

In 1892, Messrs. Sandberg, MacDougal & Heller collected in Latah, Nez Perce and Kootenai counties, Idaho. A report of these collections was published in the Contributions from the United States National Herbarium, by Prof. John M. Holzinger.

Prof. R. M. Horner, in 1896, collected a few specimens in the vicinity of Waitsburg, which he sent to Prof. C. V. Piper at Pullman.

Prof. C. V. Piper was professor of botany at the State College of Washington at Pullman from 1893 to 1903. Although he was mainly interested in the vascular plants during this time, he also laid the foundation of the moss collection of the State College Herbarium. He collected in the Blue Mountains, Thatuna Hills, Kamiak Butte, Spokane, Almota, and Pullman.

No one has contributed more to the knowledge of the moss flora of the area than has Dr. F. L. Pickett, Professor of Botany at the State College. Since 1914 he has collected in various parts of eastern Washington and adjoining Idaho, and his specimens comprise the majority of those in the State College Herbarium that represent the moss flora of the region.

The collection of Bryophytes in the Herbarium of the State College of Washington is the basis of this flora. I am under special obligation to Dr. Harold St. John for his advice, encouragement, helpful sug-

gestions and criticism of the manuscript. I am indebted to Dr. A. J. Grout of New York City for determining or verifying many difficult specimens, and to Dr. J. W. Bailey of Seattle for looking over some of my Snake River collections. I wish, also, to thank Dr. T. C. Frye of the University of Washington for assistance at various times. The map, which originally appeared in *Flora of Southeastern Washington and Adjacent Idaho,* by Charles V. Piper and R. Kent Beattie in 1914, is used by permission.

ANALYTICAL KEY TO THE FAMILIES

Peristome teeth solid, very faintly, or not articulated. *(Nematodonteae)*

Peristome single; capsule symmetrical.

Peristome teeth 4; lid deciduous .... 1. TETRAPHIDACEÆ, 133.

Peristome teeth 32 or 64; lid not deciduous .... 2. POLYTRICHACEÆ, 134.

Peristome double; capsule asymmetrical; leaves reduced to scales .... 3. BUXBAUMIACEÆ, 136.

Peristome teeth membranous, articulated, or peristome absent. *(Arthrodonteae)*

Peristome single or none. *(Aplolepideae)*

Peristome teeth mostly 2-3 cleft to the base into filiform divisions, sometimes vertically striate below and more or less papillose above, often entire but seldom cribrose or bifid to the middle, usually straight or sometimes spirally twisted, frequently rudimentary or absent; leaves not hyaline pointed but costa sometimes excurrent.

Leaves distichous; peristome without basal membrane .... 4. FISSIDENTACEÆ, 136.

Leaves 3- or more seriate.

Calyptra cucullate, not conical-cylindrical or completely covering the capsule.

Peristome teeth sometimes vertically striate below and usually more or less papillose above, not spirally twisted; leaf cells narrowly rectangular, seldom papillose .... 5. DICRANACEÆ, 136.

Peristome teeth not vertically striate, either smooth or papillose, straight or spirally twisted; upper leaf cells often small, obscure and papillose .... 6. TORTULACEÆ, 139.

Calyptra conical-cylindrical, completely covering the capsule .... 7. ENCALYPTACEÆ, 143.

Peristome teeth usually cribrose or bifid to the middle, seldom 2-cleft to the base (Rhacomitrium), or absent (Scouleria, Hedwigia), not spirally twisted, never vertically striate, often papillose; basal membrane absent; leaves frequently hyaline pointed; plants mostly rupestral; calyptra either cucullate or mitrate .... 8. GRIMMIACEÆ, 143.

Peristome usually double, or occasionally single or absent. (*Diplolepideae*)

Capsules terminal; stems usually erect, dichotomously branched. (*Diplolepideae Acrocarpae*)

Inner peristome usually distinct, without a basal membrane.

Outer teeth sometimes joined at base, superimposed on, and opposite to the non-keeled processes, sometimes joined at the apices to form a small disc; intermediate cilia none; leaf-cells loose, smooth; calyptra smooth, cucullate; plants annual or biennial, terrestrial .... 9. FUNARIACEÆ, 150.

Outer teeth alternating with the processes which are keeled and always free, sometimes rudimentary or absent; upper leaf-cells dense, roundish, often papillose; calyptra mitrate and more or less villous or cucullate and glabrous; plants perennial, arboreal or rupestral .... 10. ORTHOTRICHACEÆ, 155.

Inner peristome from a more or less distinct basal membrane; calyptra cucullate.

Capsules strongly plicate and furrowed when dry (in ours)

Capsules globose or nearly so; cilia none or rudimentary; inner peristome shorter than the outer .... 11 BARTRAMIACEÆ, 157.

Capsules ovoid-cylindrical; cilia of inner peristome well developed, of equal length with the outer .... 12. AULACOMNIACEÆ, 159

Capsules smooth or nearly so when dry.

Inner peristome of cilia only, opposite the teeth; upper leaf cells slightly papillose on the back .... 13. TIMMIACEÆ, 159

Inner peristome of keeled segments, alternating with the teeth; intermediate cilia often present and well developed; leaf cells smooth .... 14 BRYACEÆ, 160.

Capsules usually lateral; stems usually prostrate or ascending, usually pinnately or irregularly branched, rarely dichotomous; calyptra smooth, cucullate. (*Diplolepideae Pleurocarpae*)

Terrestrial or rupestral, seldom aquatic; capsules exserted.

Leaves mostly papillose, cells usually short, seldom more than 3:1; cilia usually rudimentary or absent .... 15 LESKEACEÆ, 165.

Leaves rarely papillose, cells usually elongated; cilia usually present and complete.

- Basal joints of peristome teeth usually transversely striate (except Climacium); leaves not lacerate-dentate .... 16. Hypnaceæ, 168.
- Basal joints of peristome teeth not transversely striate.
  - Leaves complanate .... 17. Neckeraceæ, 181.
  - Leaves not complanate.
    - Minute slender plants 2-5 mm. high, with non-decurrent, lacerate-dentate leaves (in ours) .... 18. Fabroniaceæ, 181.
    - Medium sized plants 4-8 cm. long; leaves decurrent, entire or nearly so (in ours) .... 19. Leucodontaceæ, 182.
- Aquatic, long slender mosses with immersed capsules .... 20. Fontinalaceæ, 182.

KEY TO GYMNOSTOMOUS AND CLEISTOCARPOUS GENERA

- Capsule immersed or emergent; calyptra cucullate.
  - Capsule cleistocarpous, ovoid .... Phascum, 141.
  - Capsule operculate.
    - Capsule urceolate, 8-striate and contracted below the mouth when dry and empty; lid with a short oblique beak .... Zygodon, 155.
    - Capsule globose or oblate-spheroidal, smooth; lid flat or convex.
      - Capsule globose; lid convex .... Hedwigia, 150.
      - Capsule oblate spheroidal; lid flat .... Scouleria, 145.
- Capsule exserted.
  - Capsule cylindrical, striate; lid with a straight, slender beak; calyptra conical-cylindrical completely covering the capsule .... Encalypta, 143.
  - Capsule ovoid or cylindrical; lid obliquely beaked or convex; calyptra cucullate.
    - Capsule cylindrical, smooth; lid oblique .... Pottia, 141.
    - Capsule ovoid.
      - Capsule smooth; lid oblique .... Hymenostylium, 142.
      - Capsule striate; lid convex .... Anacolia, 158.

KEY TO THE GENERA

Leaves absent at fruiting time; capsule inserted obliquely on the seta .... BUXBAUMIA, 136.

Leaves present; capsule not oblique,

A. At least the upper leaves with hyaline points or excurrent costæ.

Plants minute, 2-8 mm. high .... PHASCUM, 141.

Plants larger, 1-10 cm. high.

Leaves serrate.

Median cells roundish-quadrate .... CLAOPODIUM, 167.

Median cells oblong-linear .... PHILONOTIS, 158.

Leaves entire or essentially so.

Leaves lanceolate or linear-lanceolate.

Leaves 6-15:1, linear-lanceolate, stiff; cells opaque .... POLYTRICHUM, 134.

Leaves wider.

Basal cells linear, nodulose .... RHACOMITRIUM, 144.

Basal cells oblong or quadrate, usually smooth-walled .... GRIMMIA, 146.

Leaves oblong, obovate, ovate or ovate-lanceolate.

Leaves filiform-acuminate.

Median cells linear .... DREPANOCLADUS, 176.

Median cells rectangular .... FUNARIA, 150.

Leaves acute or obtuse.

Cells rhomboidal .... BRYUM, 163.

Cells otherwise.

Leaves oblong or obovate.

Hair-point spinulose-denticulate; cells papillose .... TORTULA, 139.

Hair-point smooth or nearly so.

Cells papillose; calyptra conical-cylindrical .... ENCALYPTA, 143.

Cells not papillose; calyptra cucullate. TORTULA, 139.

Leaves ovate or ovate-lanceolate.

Points of upper leaves hyaline .... GRIMMIA, 146.

Points of leaves green .... CERATODON, 138.

AA. Leaves without hyaline points or excurrent costæ.

B. Costa short and double, or sometimes indistinct or obsolete; plants pleurocarpous.

Median cells 7:1 or less.

Leaves lacerate-dentate, plane .... FABRONIA, 182.

Leaves denticulate, concave.

Upper cells irregularly oval-rhomboidal; plants pale glaucous green .... MYURELLA, 165.

Upper cells linear-vermicular; plants olive green .... Pterigynandrum, 166.

Median cells 10-15:1 or more.

Aquatic; leaves ecostate .... Fontinalis, 183.

Terrestrial; leaves shortly and often indistinctly bicostate.

Leaves complanate .... Plagiothecium, 177

Leaves non-complanate.

Leaves 3-5 mm. long, often transversely rugose; paraphyllia often present .... Hylocomium, 180.

Leaves 1-2.5 mm. long, usually not transversely rugose; paraphyllia usually absent .... Hypnum, 178.

BB. Costa single.

C. Median and upper cells 5:1 or longer.

Plants acrocarpous.

Leaves papillose, serrate in upper half .... Philonotis, 158.

Leaves not papillose, entire, or serrate near apex.

Leaves linear-setaceous .... Leptobryum, 162.

Leaves wider.

Cells parenchymatous, often porose .... Dicranum, 137

Cells prosenchymatous, never porose.

Leaves usually lanceolate; costa usually sub-percurrent .... Webera, 162.

Leaves ovate; costa percurrent or excurrent .... Bryum, 163.

Plants pleurocarpous.

Cells sharply papillose on lower surface of leaf .... Pterigynandrum, 166.

Cells smooth.

Leaves more or less plicate.

Leaves somewhat obtuse, strongly serrate at apex; stems more or less dendroid, erect or ascending .... Climacium, 169,

Leaves acute or acuminate, entire or denticulate; stems prostrate.

Lid usually long beaked; median cells linear; capsule ovoid .... Cirriphyllum, 171.

Lid usually conical to short beaked.

Capsule ovoid; median cells long rhomboidal .... Brachythecium, 171.

Capsule cylindrical; median cells linear .... Camptothecium, 174.

Leaves not plicate.

Leaves serrate .... Eurhynchium, 170.

Leaves entire or nearly so.
Cells linear, 10-30:1 .... Drepanocladus, 176.
Cells rhomboidal, 5:1 or less .... Amblystegium, 176.
CC. Median and upper cells 3:1 or less.
D. Leaves serrate or dentate, at least near apex.
Leaves acuminate.
Costa sub-percurrent, plants pleurocarpous.
Cells with a sigmoid curve .... Antitrichia, 182.
Cells roundish-hexagonal to rhomboidal.
Cells roundish or hexagonal.
Leaves imbricated when dry .... Pseudoleskea, 166.
Leaves crisped and curled when dry. Claopodium, 167.
Cells rhomboidal, smooth .... Eurhynchium, 170.
Costa percurrent; cells not papillose; plants acrocarpous.
Leaves lanceolate; capsule cylindrical.
Basal cells nodulose or sinuose .... Rhacomitrium, 144.
Basal cells smooth walled .... Ptychomitrium, 145
Leaves linear-lanceolate; capsule globose.
Leaves curled when dry .... Bartramia, 158.
Leaves straight when dry .... Anacolia, 158.
Leaves acute or obtuse.
Leaves acute
Leaves bordered with narrow cells, or border thickened.
Leaves with longitudinal lamellæ on inner surface .... Catharinæa, 135.
Leaves not lamellate.
Upper cells prosenchymatous .... Bryum, 163.
Upper cells parenchymatous .... Mnium, 160.
Leaves not bordered.
Basal cells isodiametrical, green .... Aulacomnium, 159.
Basal cells elongate-rectangular, orange-tinted .... Timmia, 160.
Leaves obtuse.
Borders thickened; plants blackish when dry; leaves not complanate; plants acrocarpous .... Scouleria, 145.
Borders not thickened; plants yellowish or brownish green, pleurocarpous.
Leaves complanate; cells rhomboidal .... Neckera, 181.
Leaves not complanate; cells hexagonal.
Leaves strongly papillose, crisped when dry .... Anomodon, 166.
Leaves not papillose or crisped when dry .... Porotrichum, 169.
DD. Leaves entire or essentially so.

- Leaves distichous .... Fissidens, 136.
- Leaves pluri-seriate.
  - Leaves obovate, 6-8 mm. long, emarginate or apiculate .... Mnium, 160.
  - Leaves otherwise.
    - Margins plane.
      - Median cells rhomboidal; leaves lanceolate; plant pleurocarpous .... Amblystegium, 176.
      - Median cells rounded or hexagonal; plant acrocarpous.
        - Rupestral; leaves narrowly lanceolate, curled when dry .... Zygodon, 155.
        - Not rupestral.
          - Leaves of two kinds, ligulate and ovate, not curled when dry .... Tetraphis, 133.
          - Leaves not as above .... Funaria, 150.
    - One or both margins recurved or revolute.
      - Basal cells linear, nodulose .... Rhacomitrium, 144.
      - Basal cells rectangular or quadrate, smooth walled or sinuose, not nodulose.
        - Rupestral or arboreal.
          - Leaves scarcely twisted when dry.
            - Leaves ovate-lanceolate; cells small, rounded, dense, opaque, not papillose .... Grimmia, 146.
            - Leaves narrowly lanceolate; cells distinct, incrassate, often more or less papillose.
              - Calyptra campanulate-mitrate, more or less villous; lid straight beaked; peristome present .... Orthotrichum, 156.
              - Calyptra cucullate, glabrous; lid obliquely beaked; peristome none .... Hymenostylium, 142.
          - Leaves twisted and curled when dry; cells very obscure, dense, papillose .... Barbula, 142.
        - Terrestrial, or growing on roofs.
          - Upper cells dense, obscure, papillose .... Barbula, 142.
          - Upper cells laxer, distinct, not, or very slightly papillose.
            - Median cells quadrate or roundish-quadrate .... Ceratodon, 138.
            - Median cells truncate-hexagonal. Funaria, 150.

MOSS FLORA OF SOUTHEASTERN WASHINGTON AND ADJACENT IDAHO

BRYALES.

Low, mostly tufted, gregarious mosses; protonema normally filamentous (except Tetraphidaceæ and Buxbaumiaceæ); rhizoids septate; calyptra normally apical; stems usually containing a distinct central strand of conductive tissue; leaves alternate, simple, mostly 1-stratose, occasionally 2-3-stratose, sessile, not sphagnoid; costa median, single, double or absent, composed of elongated thick-walled sclerenchyma containing conductive tissue; capsule usually operculate, on a more or less elongate non-hyaline seta; peristome single, double or none; annulus and columella usually present.

A sharply defined and specialized order constituting by far the largest number of the Bryophyta.

Family 1. TETRAPHIDACEÆ.

A family of small tufted mosses with slender leafy stems, and sometimes with terminal gemmiferous cups; leaves of two kinds, early frondiform or ligulate leaves appearing on the protonema, and later ovate or lanceolate leaves with roundish-hexagonal cells; capsule erect, exserted on a long seta, smooth, ellipsoidal or cylindrical; annulus none; calyptra mitrate, plicate; peristome of 4 solid, equidistant teeth, or absent.

1. TETRAPHIS.

With the characters of the family; peristome present.

Tetraphis pellucida [L.] Hedw. (*Georgia pellucida* Rabenh.). Plants densely tufted, 2-3 cm. high, green above, brownish below; stems of two kinds, gemmiferous, bearing terminal cup-shaped gemmæ, and fertile stems bearing capsules, both forms, however, seldom appearing together; lower leaves reduced, margins entire, plane; costa ceasing below the apex of the leaf; cells roundish; seta erect, slender, smooth, brownish 1-2 cm. long; capsule erect, cylindrical; calyptra mitrate, completely covering the capsule, whitish at base, roughish at apex, plicate; lid shining, conical.

On decaying wood, rare.

Family 2. POLYTRICHACEÆ.

Large perennial conspicuous plants of strong texture; stems upright, leafless and blackish below; leaves with a sheathing membranous base, narrow, frequently serrate, lamellate on upper surface; costa strong, single; cells hexagonal or quadrate; seta stout, elongated; capsule large, cylindrical or 4-6 angled; calyptra cucullate, glabrous or villous; peristome simple or none; teeth 32 or 64, short, ligulate, nonarticulate, confluent at base, united at apex; inflorescence mostly dioicous.

Leaves with numerous lamellæ, not bordered or crisped when
dry, hyaline or pellucid at apex; calyptra densely villous 1. POLYTRICHUM
Leaves with few lamellæ, bordered, not hyaline pointed,
crisped when dry; calyptra glabrous______________ 2. CATHARINÆA.

1. POLYTRICHUM. HAIR-CAP MOSS.

Large tufted plants with simple, erect, woody, triangular stems; leaves opaque with numerous lamellæ on the upper surface, not bordered or crisped when dry; capsules with stomata, 4-6 angled; calyptra cucullate, covered with long deflexed hairs; lid straight beaked; peristome teeth usually 64.

Plants 2-10 cm. high; leaf-margins entire, inflexed.
  Leaf-awns reddish, less than ¼ the length of the leaf___ *P. juniperinum*
  Leaf-awns hyaline, ⅓-⅙ the length of the leaf________ *P. piliferum.*
Plants 15-45 cm. high; leaf-margins serrate, not inflexed... .. *P. commune*

Polytrichum juniperinum [Willd.] Hedw. Plants loosely tufted, glaucous or blue-green; stems erect, mostly simple, 3-10 cm. high; leaves linear-lanceolate, entire on the margins but toothed on the lower surface near the apex; awns colored, short, less than ¼ the length of the leaf; seta erect, reddish, shining, 4-6 cm. long; capsule tetragonal, longer than wide, erect or ascending, sharply angled, 4-5 mm. long; calyptra large, whitish-villous, completely covering the capsule; lid apiculate, reddish.

Dry meadows and open woods, growing on the ground and fruiting in summer.

Polytrichum piliferum [Schreb.] Hedw. Similar to *P. juniperinum;* stems 2-5 cm. high; seta 2.5-3.5 cm. long; leaf-awns hyaline, ⅓-⅙ the length of the leaf.

Common on rocky hillsides, fruiting in summer, or usually sterile in this area.

Polytrichum commune [L.] Hedw. Plants erect, 15-45 cm. high, dark green; leaves linear-lanceolate, serrate, pellucid at apex; seta erect, 6-10 cm. long;

capsule 4-angled, 3.5-4 mm. long; calyptra covering the capsule, densely villous with yellowish brown hairs; lid with a short beak about 1 mm. long.

In swampy ground in woods, northern Idaho.

2. CATHARINÆA.

Plants in loose soft spreading patches; leaves lingulate or lanceolate, bordered, serrate, lamellate on the upper surface, crisped when dry; capsule cylindrical, often curved; calyptra glabrous; lid long beaked; peristome teeth 32.

Lamellæ 3-8 cells high; calyptra roughened at apex.
  Costa and lamellæ constituting ⅙-⅒ of the width of the upper half of the leaf; lamellæ 3-5 cells high; inflorescence autoicous; capsules arcuate .... *C. undulata.*
  Costa and lamellae constituting ⅓-¼ of the width of the upper half of the leaf; lamellæ 5-8 cells high; inflorescence dioicous; capsules nearly erect and straight .... *C angustata.*
Lamellæ 9-13 cells high; calyptra smooth at apex; costa and lamellæ constituting ⅙-⅒ of the width of the upper half of the leaf; inflorescence dioicous; capsules nearly erect or subarcuate .... *C. Selwyni.*

Catharinæa undulata [L.] Web. & Mohr. Stems erect, 2-5 cm. high, densely tufted, dark green; leaves lingulate, 4-6 mm. long, transversely undulate when moist, crisped when dry, sharply serrate, bordered with narrow cells, spinulose on lower surface near apex, lamellate on upper surface; cells chlorophyllose, hexagonal above, quadrate or rectangular below; setæ erect, solitary or in pairs, reddish brown, flexuose, 1-3.5 cm. long; capsules brown, cylindrical, curved; lid subulate, nearly as long as the capsule; calyptra cucullate, roughened at apex.

Common on moist soil in woods.

A variety, *Atrichum undulatum* [L.] Beauv., var. *altecristatum* Ren. & Card which has "lamellae of the leaves much higher than in the typical form; capsule narrower and erect",[4] was collected by *Sandberg, MacDougal & Heller* at Lewiston in 1892.[5]

Catharinæa angustata Brid. Plants of a darker color than *C. undulata;* leaves narrower and more densely areolated with smaller cells.

On damp soil in shaded situations. Almota Canyon, *Pickett* 655, 659; Pullman, *E. McKay,* July 16, 1929.

Catharinæa Selwyni (Aust.) E. G. Britt. More slender than *C. undulata* and perhaps not distinct from that species.

On moist soil in woods.

[4] Bot. Gaz. 15: 58, 1890.
[5] Contr. U. S. Nat. Herb. 3: 278, 1896.

Family 3. BUXBAUMIACEÆ.

Small acaulescent or short stemmed mosses growing on soil or decaying wood; leaves small, few or none; capsule large, ovoid, oblique, asymmetrical; calyptra mitrate, very small; lid conical; peristome double, outer teeth numerous, erect, filiform; inner teeth united in a plaited membranous cone.

1. BUXBAUMIA.

Acaulescent annuals; leaves minute, basal, ovate or lanceolate, evanescent; capsule brown, obliquely attached, flattened on the upper surface, convex below; seta short, stout, papillose; lid conical.

Buxbaumia Piperi Best. Leaves reduced to yellowish, laciniate bracts; seta 6-10 mm. high; peristome teeth linear, papillose.

In woods, on decaying wood or on moist ground, not common. Moscow Mountain, *Piper* 404, *Pickett* 220. This species bears the name of Dr. Charles Vancouver Piper, 1867-1926.

Family 4. FISSIDENTACEÆ.

Leaves distichous, on one plane, clasping the stem by the basal part of the upper side; costa usually present; cells hexagonal or rounded, small, uniform, chlorophyllose; inflorescence autoicous or dioicous; capsule small, smooth, exserted, stomatose, either lateral or terminal; peristome dicranoid; teeth 16, forked, colored, articulate, often papillose above.

1. FISSIDENS.

With the characters of the family.

Fissidens limbatus Sull. Plants 0.5-1 cm. high; leaves 8-10 pairs, oblong, acute or acuminate, with pellucid borders; costa thick, percurrent; cells quadrate; capsule cylindrical, sub-erect; teeth inflexed, 2-cleft to near the base.

Moist ground, rare. Pullman, *Lawrence* 305.

Family 5. DICRANACEÆ.

Plants tufted; stems leafy, dichotomously branched; leaves narrow, costate; cells small, usually narrow, often inflated in the basal angles; inflorescence autoicous or dioicous; capsule exserted, cylindrical, frequently cernuous; calyptra smooth, glabrous, usually cucullate; lid usually beaked; annulus usually present; teeth 16, deeply 2-cleft, transversely articulated, *often* reddish, outer usually with vertical striæ.

Teeth entire or cribrose; leaves entire, crisped when dry; capsule smooth or nearly so when dry; lid obliquely beaked 1. DICRANOWEISIA
Teeth deeply cleft.
Alar cells differentiated; leaves lanceolate or subulate; lid usually long beaked; teeth unequally 2-3 cleft to the middle or below.......... 2. DICRANUM.
Alar cells not differentiated; leaves ovate or lanceolate; lid conical or short-beaked; teeth with thickened joints, regularly cleft to near the base into 2 filiform divisions.... 3. CERATODON.

1. DICRANOWEISIA.

Plants densely tufted; leaves lanceolate, entire, smooth, crisped when dry; basal cells angular, more or less distinct; inflorescence autoicous; capsule erect, smooth; teeth entire, cribrose or cleft at the apex only, not vertically striate on the outer surface.

Dicranoweisia contermina Ren. & Card. Plants pulvinate, yellowish green; stems branched 1-3.5 cm. high, radiculose at base; leaves spreading when moist, crisped when dry, 2-4 mm. long, elongate-lanceolate, acuminate; margins flat, entire; costa percurrent or slightly excurrent; lower cells elongate-rectangular, upper ones roundish; seta erect, brownish, 1-1.5 cm. high; capsule erect, symmetrical, ellipsoid-cylindrical, 1.5-2 mm. long, roughened when dry; lid with a long slender beak.

First found at Farmington Landing by Messrs. *Sandberg, MacDougal* & *Heller* in 1892.

2. DICRANUM.

Plants tufted, erect, mostly yellowish green, often tall; leaves lanceolate, usually canaliculate, often falcate-secund, costate; cells elongate, rectangular at base; alar cells usually differentiated; seta erect; capsule exserted, curved, erect or ascending; lid beaked; calyptra cucullate; teeth unequally 2-3 cleft to the middle or below.

Leaves serrate to near the middle; cells more or less porose.
Leaves erect or nearly so, transversely undulate when moist *D. Bonjeani.*
Leaves usually falcate-secund, not, or rarely transversely undulate.......... *D. scoparium.*
Leaves entire, or denticulate at the apex only; cells not porose.
Leaf-apices nearly all broken off; capsule erect, cylindrical *D. strictum.*
Leaf-apices less fragile; capsule slightly curved.......... *D. Schisti.*

Dicranum Bonjeani DeNot. Plants pale green, 5-15 cm. high; leaves erect when dry, only slightly secund when moist, 4-6 mm. long, wider at the apex and distinctly transversely undulate when moist; seta pale; capsule arcuate-cylindrical, faintly striate.

On soil or decaying wood, usually in marshy places, fruiting in late summer, or frequently sterile.

Dicranum scoparium [L.] Hedw. Plants yellowish green or brownish, 4-10 cm. high, tufted, radiculose at base; leaves usually falcate-secund, lanceolate, concave, acuminate, 5-8 cm long, serrate above the middle; cell-walls porose; seta solitary, reddish; capsule cylindrical, arcuate, cernuous when mature, smooth, strumose; lid straight beaked.

On soil, rocks, bases of trees, decaying wood and fallen logs in woods. Variable, and consisting of many forms. Fruiting in summer, or frequently sterile.

Dicranum strictum Schleich. Plants tufted, yellowish green, 2-5 cm. high; stems slender, fragile; leaves erect or spreading, somewhat curved when dry, 5-7 mm. long, lanceolate at base, canaliculate-subulate above, apex usually broken off, entire or denticulate; basal cells quadrate; median cells rectangular; capsule cylindrical, 2-3 mm. long, smooth, erect; lid straight beaked; annulus broad, distinct; inflorescence dioicous.

On decaying wood, in mountain forests, common.

Dicranum Schisti (Gunn.) Lindb. Plants tufted, 2-3 cm. high; leaves somewhat crisped when dry, lanceolate-subulate, entire or nearly so, 3-4 mm. long; costa homogeneous; seta 10-15 mm. long; capsule slightly curved, indistinctly strumose, smooth or nearly so when dry and empty, about 1.5 mm. long; lid obliquely beaked; annulus broad, distinct; inflorescence autoicous, male flower far below the perichætium.

On rocks in the mountains, rare.

3. CERATODON.

Plants tufted, leaves ovate or lanceolate, margin revolute; cells roundish-quadrate, smooth or papillose; inflorescence usually dioicous; capsule exserted, reddish brown, ellipsoid-cylindrical, with a distinct neck, sulcate when dry; lid conical; teeth 16, cleft to near the base into 2 filiform divisions, papillose, articulate; calyptra cucullate.

Ceratodon purpureus [L.] Brid. Plants dark green; stems slender, often branched at the apex, erect, 2-8 cm. high; leaves spreading when moist, twisted when dry, lanceolate to ovate, acute, margin revolute, entire, or toothed at the apex; costa percurrent or slightly excurrent; upper cells quadrate; basal cells 3-8 times as long as broad; capsule cylindrical, inclined or upright, reddish brown or purplish, sulcate and brown when mature, strumose at base; seta 2-3 cm. high, dark red in age.

On soil, roofs, etc., very common and variable, fruiting abundantly in spring. A variety with the costa excurrent and the capsule scarcely strumose is var. **conicus** (Hampe) Moenk. (*C. conicus* (Hampe) Lindb.).

Article 46 of the International Rules, (Vienna 1905 and Brussels 1910), states, "When two or more groups of the same nature are united, the name of the oldest is retained. If the names are of the same date, the author chooses, and his choice cannot be modified by subsequent authors" Sir W. J. Hooker in Smith's English Flora 5: 32, 1844, unites *C purpureus* and *C purpurascens* under Didymodon, choosing *D purpureus* Hook. & Tayl. Braithwaite, Limpricht and Paris come to a similar conclusion, using the generic name Ceratodon. Therefore the correct name for this plant appears to be *Ceratodon purpureus* [L.] Brid., Bry. Univ. 1: 480, 1826, not *C. purpurascens* (Hedw.) Jennings, Mosses of Western Pennsylvania 57, 1913.

Family 6. TORTULACEÆ.

Stems leafy, radiculose at the base; leaves several-seriate, linear to spatulate, costate; cells parenchymatous, often hyaline at the base of the leaf and opaque above; inflorescence usually autoicous or dioicous; capsule erect or nearly so, symmetrical, ovoid or cylindrical; peristome single or none; teeth 16, straight or spirally twisted, entire or 2-3-cleft into papillose filiform divisions; calyptra mostly narrow and cucullate.

- Leaves usually broadest at or above the middle, wide at apex; costa excurrent.
  - Peristome teeth 32, from a high basal membrane, united into a spirally twisted tube, or if absent or rudimentary then leaves with one or two vertical lamellæ or oval sacs on inner surface........ 1. Tortula.
  - Peristome teeth absent or rudimentary (in our species); leaves without lamellæ........ 2. Pottia.
- Leaves broadest below the middle, gradually acuminate.
  - Plants minute, (2-8 mm. high); capsule immersed or emergent, apiculate, cleistocarpous........ 3. Phascum.
  - Plants larger (1-10 cm. high); capsule long-exserted, beaked, opening by a lid.
    - Peristome absent........ 4. Hymenostylium.
    - Peristome present........ 5. Barbula.

1. TORTULA.

Plants tufted, radiculose near the base; stems leafy; leaves oblong or spatulate, usually obtuse; cells parenchymatous; basal cells usually hyaline; upper cells smaller, obscure, chlorophyllose, often papillose; costa excurrent; capsule on a long straight seta, erect, symmetrical, cylindrical or rarely ovoid; calyptra cucullate, usually smooth; peristome single or none; teeth 16, papillose, straight or spirally twisted, entire or 2-3 cleft into filiform branches.

- Leaves concave, with lamellæ or sacs on upper surface; hair-point entire; margins slightly incurved; peristome none........ *T. pusilla.*
- Leaves not concave, without lamellæ or sacs; peristome present.
  - Hair-points spinulose; cells papillose.
    - Margins recurved........ *T. ruralis.*
    - Margins plane or nearly so above........ *T princeps.*
  - Hair-points entire; cells smooth; margins plane, with elongated cells near base........ *T. mucronifolia.*

Tortula pusilla Mitt. (*Pottia cavifolia* Ehrh.) Plants in low dense tufts, bright green; leaves oblong or obovate, concave, with 1-2 oval sacs on the upper surface near the apex; margins somewhat incurved; costa long-excurrent, especially in the lower leaves, or the upper leaves merely mucronate; lower cells rectangular; upper cells roundish-quadrate; seta erect, red, 4-8 mm. high; capsules numerous, ellipsoidal or short-cylindrical, reddish brown; peristome none; lid with a slender oblique beak.

On soil on open hillsides, not uncommon, fruiting in spring.

Tortula ruralis [L.] Schwaegr. Plants in loose tufts, bright green; stems erect, branched, 3-8 cm. high, reddish brown below; leaves oblong-spatulate, obtuse, margins recurved; upper leaves recurved when moist, twisted when dry; costa prominent, reddish, excurrent into a strongly spinulose hyaline or reddish hair-point, equalling or slightly shorter than the leaf-blade; lower cells rectangular, upper cells roundish or hexagonal, papillose, somewhat indistinct; seta erect, reddish, 2-3 cm. high; capsule erect or ascending, cylindrical, slightly curved; lid half the length of the capsule; teeth twisted, pink, united below the middle; inflorescence dioicous.

Rocks and tree trunks, very common, fruiting in May. This is one of the most abundant species in the region. It frequently covers large areas on rocky hillsides where it is often associated with *Grimmia montana, Camptothecium aeneum* and *Polytrichum piliferum.* With *Orthotrichum affine, var. fastigiatum* it occurs abundantly on the trunks of Lombardy Poplar trees.

ssp. **norvegica** (Wahl.) Dixon. (*Tortula aciphylla* Hartm.) Differing from the species in having the leaves more acute, and the costa excurrent into a shorter, nearly entire hair-point.

On basalt cliffs.

Tortula princeps DeNot. (*Syntrichia princeps* Mitt.) (*Barbula Muelleri* B S.G.) (*B. princeps* C. Muell.) Similar to *T. ruralis.* Hair-point sparingly denticulate; leaf-margins plane or nearly so above; leaves erect or spreading, not recurved; inflorescence synoicous.

On decaying wood or rocks, rare.

Tortula mucronifolia Schwaegr. (*Syntrichia mucronifolia* Brid.) (*Barbula mucronifolia* B.S.G.) Plants loosely tufted; leaves oblong-spatulate; hair-points not spinulose; margins plane, or reflexed below, with elongated cells near the base; cells not papillose.

On rocks or soil, not common.

2. POTTIA.

Small, tufted, terrestrial mosses; leaves ovate or oblong, without lamellæ; costa excurrent or percurrent; upper cells roundish-hexagonal, papillose, lower cells elongated, smooth; seta straight; capsule exserted, erect, symmetrical, ellipsoidal or cylindrical, cleistocarpous, gymnostomous, or peristomate with 16 teeth; lid mostly obliquely beaked; calyptra cucullate.

Pottia truncata (Hedw.) Fuernr, var. **intermedia** (Turn.) comb nov *Gymnostomum intermedium* Turn., Musc. hib. 7, 1804. *Pottia intermedia* Fuernr., Flora 12, p. 2, Erganz. 10, 1829. *Pottia truncatula* [L.] Lindb, ssp. *intermedia* (Fuernr.) Dixon, Stud. Handb. Brit. Mosses, ed. 1, 1896.

According to the International Rules (Chap. 3, Sect. 1, Art. 19b), *Bryum truncatulum* of Linnaeus, Sp. Pl. 1119, 1753, is invalidated by *Gymnostomum truncatum of* Hedwig, Sp. Musc. 30, 1801.

Plants tufted, dull greenish; leaves oblong or spatulate, about 2 mm. long; costa excurrent into a smooth, slender, yellowish green hair-point; margins revolute near the middle of the leaf, minutely roughened near the apex with projecting papillæ; upper cells roundish-hexagonal, chlorophyllose, slightly papillose; lower cells hyaline, smooth, rectangular; seta purplish; capsule cylindrical, 1 mm. long; calyptra smooth, cucullate; annulus broad; peristome obsolete or nearly so.

On basaltic boulders, common along the Snake River.

3. PHASCUM.

Minute cleistocarpous plants; leaves ovate or lanceolate, entire, usually papillose above; upper cells quadrate-hexagonal; lower cells rectangular; costa slender, excurrent; capsule immersed or emergent, sub-globose or ovoid, short pointed, without a distinct lid; calyptra usually cucullate.

Phascum cuspidatum [Schreb.] Hedw., var. **piliferum** Hook. & Tayl. Plants in small, dense, deep green tufts, 2-3 mm. high; leaves crowded, erect, somewhat twisted when dry; upper leaves oblong-lanceolate, somewhat revolute on the margins, acute; costa long excurrent; lower cells rectangular, upper cells hexagonal; capsules solitary or 2-3 together, immersed.

On soil, apparently rare in this region, fruiting in spring.

4. HYMENOSTYLIUM.

Stems leafy, tufted, somewhat radiculose, 3-angled in cross-section, without a central strand; leaves lanceolate, acuminate; inflorescence dioicous; capsule erect, symmetrical, smooth, ovoid or obovoid; peristome none; lid obliquely long beaked, remaining attached to the columella; calyptra cucullate.

Hymenostylium curvirostre [Ehrh] Mitt. (*Weisia*) (*Pottia*) (*Barbula*) (*Gymnostomum*) Densely tufted, 3-10 cm. high; bright green above, brown-green below; stems erect, slender, branched; leaves erect or somewhat spreading when moist, straight when dry, lanceolate, acuminate; seta erect, slender 4-8 mm. high, yellowish or pale reddish brown; capsule erect, symmetrical, shining, dark reddish brown; lid obliquely beaked, remaining attached to the columella, beak longer than the capsule

Moist rocks, rare

5. BARBULA.

Similar to *Tortula*. Leaves broadest near the base, gradually acuminate to a more or less acute apex.

Leaves acute or obtuse.
  Beak less than ½ length of capsule; stems 1-2 cm. high..... *B convoluta*.
  Beak equalling capsule; stems less than 1 cm. high.............. *B eustegia*.
Leaves long acuminate; beak less than ½ length of capsule... *B. vinealis*.

Barbula convoluta Hedw. Plants densely tufted, yellowish green, 1-2 cm. high; leaves crowded, oblong-lanceolate, erect-spreading when moist, crisped when dry; perichætial leaves long sheathing, convolute, inner ones ecostate; cells small, indistinct, at the base of the leaf elongated, hyaline; seta erect, slender, 1-2.5 cm. long, straw colored; capsule erect or ascending, cylindrical, about 3 mm. long; lid beaked.

On soil, rare. Almota, *Piper 207*.

Barbula eustegia Card. & Ther. Stems less than 1 cm. high; leaves linear-lanceolate, acute or somewhat obtuse, entire; margins plane or nearly so; cells minutely papillose, oblong or quadrate below, roundish-quadrate above; capsule cylindrical, erect or ascending, 1-2 mm. long; beak of the lid about as long as the capsule; peristome red, teeth twisted, strongly granulose.

On ground, Cedar Creek, Latah Co., Idaho, *L. F Henderson* in 1897.

Barbula vinealis Brid. (*B. fallax* Hedw., var. *vinealis* Hueb.) (*B. cylindrica* (Tayl.) Schimp., var *vinealis* (Brid.) Braithw.) Plants loosely tufted, brownish green, 2-3 cm. high; leaves twisted when dry, lanceolate, acuminate, entire; margins recurved from the base to above the middle; cells papillose, quadrate below, obscure above; capsule ellipsoid-cylindrical, erect, brown; seta reddish.

On rocks, rare, fruiting in late spring, or frequently sterile.

Family 7. ENCALYPTACEÆ.

Small tufted terrestrial mosses with mostly lingulate, costate, entire leaves which are usually curled and twisted when dry; upper cells small, opaque, papillose; lower cells hyaline, rectangular; inflorescence usually autoicous; capsule erect, exserted, cylindrical; lid slender, straight-beaked; calyptra conical-cylindrical, long beaked, smooth or plicate, persistent, sometimes fringed at base, completely covering the capsule; peristome double, or (in ours), single or absent.

One genus, which has the general characteristics of the family.

1. ENCALYPTA. Extinguisher Moss.

Old capsules striate or ribbed; peristome none or fugacious; calyptra entire or lacerate at base .... *E. vulgaris.*
Old capsules smooth; peristome present; calyptra fringed at base .... *E. ciliata.*

Encalypta vulgaris Hedw., var. **pilifera** B S G. (*E. rhabdocarpa* Schwaegr., var. *pilifera* (Funck) Nees & Hornsch.) Plants tufted, 0.5-1 cm. high; leaves lingulate, 2-4 mm. long, yellowish green, curled and twisted when dry; costa excurrent in a yellowish spinulose hair; upper cells hexagonal-quadrate, opaque, chlorophyllose, strongly papillose; lower cells rectangular, hyaline, narrowed at leaf margins, slightly thickened at the ends; seta 5-8 mm long, reddish brown; lid about 1.5 mm. long; capsules cylindrical, 2.5-3 mm. long, striate or faintly ribbed when old; calyptra entire or slightly lacerate at base, slightly scabrous at apex; peristome usually absent, or when present, consisting of short, fugacious teeth.

On soil on basaltic ledges, common, fruiting in early spring in this area.

Encalypta ciliata Hedw. (*E. laciniata* Lindb.) Plants tufted, 1-3 cm. high; leaves lingulate, mucronate, 3-5 mm. long, curled and twisted when dry, yellowish green; upper cells hexagonal-quadrate, opaque, chlorophyllose, papillose; lower cells rectangular, hyaline; margins recurved near middle; costa subpercurrent or shortly excurrent; seta 5-10 mm. long, yellowish or pale reddish; lid about 2 mm. long; capsule cylindrical, 3-5 mm. long, smooth; calyptra fringed at base, smooth at apex; peristome single, teeth lanceolate, reddish.

On rocks, rare. Latah Co., Idaho, *Piper* 216.

Family 8. GRIMMIACEÆ.

Chiefly rupestral mosses of a pulvinate or matted habit, usually blackish green at base; leaves frequently hyaline pointed, very hygroscopic, mostly ovate or lanceolate; upper cells usually opaque, often 2-3 stratose; lower cells usually longer, often sinuate or nodulose; capsule cylindrical to spheroidal, mostly symmetrical; peristome single or none; teeth 16, without a basal membrane; calyptra either mitrate or cucullate; lid more or less beaked.

Leaves costate.
- Basal cells linear, sinuose or nodulose; peristome teeth 2-cleft almost to the base .... 1. RHACOMITRIUM.
- Basal cells oblong or rectangular, not nodulose.
  - Leaves crisped when dry, without hyaline points .... 2. PTYCHOMITRIUM
  - Leaves seldom crisped when dry, often hyaline pointed.
    - Capsule oblate-spheroidal; leaves more or less toothed; costa somewhat radiculose at base .... 3. SCOULERIA.
    - Capsule ovoid to cylindrical; leaves entire; costa without radicles at base .... 4. GRIMMIA.

Leaves ecostate; peristome absent .... 5. HEDWIGIA.

1. RHACOMITRIUM.

Plants in loose tufts with spreading, branched stems; leaves lanceolate; basal cells linear, nodulose or sinuose; capsules exserted, ellipsoidal to cylindrical, smooth; calyptra mitrate, not plicate; teeth deeply 2-cleft almost to the base into straight, filiform branches.

Upper green leaf-cells twice as long as broad.
- Hyaline points of leaves, when present, papillose; capsule ellipsoidal, 1.5 mm. long .... *R lanuginosum.*
- Leaf-points not papillose; capsule cylindrical, 1.8-2.2 mm. long .... *R. microcarpum.*

Upper green leaf-cells isodiametrical or nearly so.
- Leaves muticous; costa 2-ridged on the back of the leaf .... *R. patens.*
- Leaves nearly all hyaline pointed; costa not ridged .... *R. heterostichum*

Rhacomitrium lanuginosum (Hedw.) Brid. (*R. hypnoides* [L.] Lindb.) Plants grayish green or yellowish brown, hoary, growing in extensive mats; stems spreading, 8-20 cm. long, with many slender branchlets; leaves narrowly lanceolate, acuminate to a long whitish, dentate, papillose hair-point; basal cells linear, nodulose, incrassate; upper cells broader; setæ arising from short lateral branchlets, erect, straight, rough; capsule erect, ellipsoidal, smooth, brown; teeth yellowish red, papillose, 2-cleft to the base into filiform divisions; calyptra papillose at apex; lid beaked.

On rocks or soil, rare, fruiting in spring or early summer.

Rhacomitrium microcarpum (Hedw.) Brid. (*R. ramulosum* Lindb.) Plants in low spreading yellowish green tufts, somewhat hoary; stems slender, 3-5 cm. high, with numerous short lateral branchlets; leaves lanceolate, acuminate; hair-point usually short, denticulate, flat, not papillose; leaf cells nearly all linear, nodulose; seta erect, terminal, smooth, yellowish; capsule ellipsoidal;

calyptra papillose at apex; teeth yellowish red, papillose, short, 2-cleft to the base.

Shaded rocks, local, fruiting in autumn.

Rhacomitrium patens [Dicks.] Hueb. (*Grimmia patens* B.S.G) Plants in loose tufts; stems spreading, dichotomously branched, 3-8 cm. high, black and leafless below, curved upwards, yellowish green at tips; leaves narrowly lanceolate, acuminate, entire, or slightly toothed at apex, but not hyaline hair-pointed; costa prominent on the back of leaf, 2-ridged; lower cells linear, faintly sinuose; upper cells small, dense, rounded, 2-3 stratose; seta curved, yellowish; capsule ellipsoidal, brown, plicate when dry; lid with a short straight beak, usually falling with the calyptra; teeth densely papillose, 2-cleft to the middle.

On rocks in woods, common, although frequently sterile.

Rhacomitrium heterostichum (Hedw.) Brid. Plants grayish green; stems spreading, 3-6 cm. long, often with short, tuft-like lateral branchlets; leaves lanceolate, 1.5-2.5 mm. long, loosely appressed when dry, recurved when moist, nearly all hyaline pointed; upper cells isodiametrical, basal linear, all nodulose; seta 5-10 mm. long; capsule erect, cylindrical, 2-2.5 mm. long; lid with a long straight beak half as long as the capsule; teeth densely papillose, 2-cleft to the base.

On rocks in woods.

2. PTYCHOMITRIUM.

Rupestral mosses growing in compact cushions or tufts, yellowish green; leaves lanceolate, crisped when dry, without hyaline points; cells small, roundish-quadrate, lower ones elongated, not sinuose; seta erect, straight; capsule smooth, ellipsoidal; calyptra campanulate-mitriate, plicate, deeply lobed; lid straight beaked; teeth long, deeply 2-cleft, or seldom entire, more or less papillose.

Ptychomitrium Gardneri Lesq. Plants yellowish green, blackish below, growing in rounded cushions, 2-4 cm. high; leaves crowded, lanceolate, plicate at base, crisped when dry, acuminate, toothed near apex; lower cells elongated, upper roundish, opaque; seta erect, straight 1-2 cm. long, reddish yellow; capsule erect, ellipsoidal, smooth, brown; lid slender beaked; calyptra campanulate-mitrate, plicate, lobed at base, roughened at apex; teeth deeply 2-cleft into red filiform segments.

Common on basaltic boulders in the Snake River Canyon, fruiting in spring. First collected by *H. N. Bolander* in Dardanelles Canyon, Forest Hill, California.

3. SCOULERIA.

Plants blackish green, rupestral, loosely tufted; stems elongated, dichotomously branched, leafy; leaves thickish, chlorophyllose, lanceolate to lingulate, more or less toothed, muticous; cells small, roundish-hexagonal, smooth, quadrate or rectangular at base; capsules upright on short lateral branches, oblate-spheroidal, immersed; seta very short; peristome present or absent; teeth 16, short, more or less bifid; lid flat, persistent on the columella; calyptra large, cucullate.

Scouleria marginata E. G. Britt. Plants tufted, blackish, except at the tips of the branches; stems 3-5 cm. long, dichotomously branched, leafy above, nearly leafless below; leaves oblong-lingulate, serrate in the upper half, obtuse and entire at the apex, 3-4 mm. long, bordered by a dense double layer of cells; costa thick, percurrent or sub-percurrent; cells small, roundish-hexagonal, those at the base rectangular; capsules small, oblate-spheroidal, immersed; lid flat, persistent on the columella; peristome none.

On rocks along the Spokane River, Spokane, *Piper* 226. First collected by *Sereno Watson* at Spokane Falls in 1870.

4. GRIMMIA.

Small, often densely tufted or pulvinate rupestral mosses, usually blackish green at base; stems erect or ascending, leafy, usually with a central strand, radiculose at base; leaves lanceolate or ovate, acuminate, entire, often hyaline-pointed; costa single; upper cells small, roundish-quadrate, often opaque; basal cells usually elongated; capsule ovoid to cylindrical; calyptra smooth, cucullate or mitrate; teeth cleft to the middle, cribrose or entire, rarely absent.

Capsule immersed, longer than the seta; columella attached to the lid and falling with it. (*Schistidium*)
  Upper leaves with hyaline hair-points.
    Leaf-margins recurved; calyptra mitrate.................... *G. apocarpa.*
    Leaf-margins plane; calyptra cucullate.................... *G. ambigua.*
  Leaves all muticious.
    Leaf-margins plane.................... *G. atricha.*
    Leaf-margins recurved or revolute.................... *G. alpicola.*
Capsule emergent or exserted, shorter than the seta; columella unattached to the lid; upper leaves with hyaline hair-points.
  Seta arcuate when moist; capsule longitudinally ribbed when dry. (*Eugrimmia*)
    Leaves narrowly lanceolate; capsule cylindrical.................... *G. trichophylla.*
    Leaves ovate; capsule ovoid.................... *G. pulvinata.*
  Seta straight or nearly so when moist; capsule smooth or nearly so. (*Guembelia*)

Upper half of leaf unistratose, except on the margins where it may be bistratose;[1] basal cells rectangular, non-sinuose; calyptra plicate, lacerate at base; lid straight beaked.................... *G. calyptrata.*

Upper half of leaf 2-3 stratose; calyptra not plicate or lacerate at base.

  Basal cells not at all sinuose, either quadrate or rectangular.

    Upper leaves ovate or deltoid, with a strongly spinulose hair-point; calyptra mitrate; lid with a short straight beak.................... *G. campestris*

    Upper leaves lanceolate or oblong-lanceolate; hair-point smooth or sparingly spinulose; calyptra cucullate.

      Lid obliquely beaked.................... *G. montana.*

      Lid conical.................... *G. alpestris*

  Basal cells sinuose, linear to narrowly rectangular; hair-point nearly smooth; lid straight or obliquely short beaked.

    Calyptra mitrate.................... *G. ovata.*

    Calyptra cucullate.................... *G. commutata.*

Grimmia apocarpa [L.] Hedw. Plants dark or olive green in loose tufts that fall apart readily; stems slender, branched, 2-3 cm. high; leaves ovate-lanceolate, 1-2 mm. long, the lower muticous, the upper ones usually with a short hyaline point; lower cells slightly sinuose; margins recurved, at least in the upper half of the leaf; autoicous; capsule immersed, ovoid-cylindrical; lid beaked; calyptra mitrate; teeth red, entire or slightly cribrose, papillose.

On rocks, common, very variable and consiting of numerous forms.

Grimmia ambigua Sull. Plants small, densely pulvinate, grayish green, about 1 cm. high; stems slender, branched; leaves ovate-lanceolate or oblong, acuminate, lower ones muticous, upper with long, denticulate, hyaline hair-points; costa strong, prominent on the back of the leaf; lower cells rectangular or quadrate, upper smaller and rounded, all opaque; autoicous; capsule cylindrical, immersed; teeth entire or slightly cribrose; lid convex-apiculate; calyptra cucullate.

On basalt in the Snake River Canyon. Perhaps this is merely a form of *G. apocarpa.*

Grimmia atricha C. M. & Kindb. Similar to *G. apocarpa*; plants densely tufted; leaf margins plane; autoicous; teeth yellowish below, hyaline above, not papillose.

On rocks, rare, Pullman, *Pickett* 397.

Grimmia alpicola [Sw.] Hedw. (*G. apocarpa* [L.] Hedw., var. *alpicola* [Sw.] Hook. & Tayl.) Plants tufted, dark green; stems numerous, upright, leafy, 1-2 cm. high; leaves lanceolate or ovate-lanceolate, somewhat obtuse, muticous; cells not sinuose; costa strong; margins more or less revolute; autoicous; capsules emergent, ellipsoidal or ovoid; lid short-beaked; calyptra mitrate.

Rocky creek beds near Asotin, *Jones* 2316.

Grimmia trichophylla Grev. Plants in loose tufts, yellowish green when moist, grayish when dry, 1-2 cm. high; leaves narrowly lanceolate, acuminate, with a long hair-point; costa prominent; basal cells rectangular, 3-5 times as long as wide; upper cells much shorter and smaller, quadrate, sinuate; dioicous; seta curved when moist, becoming erect in age; capsules exserted, cylindrical, 1.5-2 mm. long, ribbed when old and dry, brown; lid beaked, beak 1 mm. long; calyptra sub-cucullate; teeth red, papillose, 2-3 cleft.

Common on basalt, and on gneiss at Granite Point, *Pickett* 565.

Grimmia pulvinata [L.] Sm. Plants in dense, round, grayish tufts; leaves oblong-lanceolate or ovate, with a long hair-point; cells nearly uniform in size and shape throughout the leaf, quadrate or nearly so; autoicous; seta curved when moist; capsule exserted, ovoid, ribbed when dry; lid shortly straight beaked, beak 0.5 mm. long; calyptra mitrate; teeth red, unequally cleft above the middle, or merely cribrose.

On basalt, very common, fruiting in spring.

This species is abundant throughout eastern Washington. It is, however, not as common as *G. montana* or *G. calyptrata*, apparently preferring situations somewhat less dry than those species. A variety with ovoid-globose capsules and the lids obtusely pointed, known as var. obtusa (Brid.) Hueb., is occasionally found.

Grimmia calyptrata Hook. (*Coscinodon calyptratus* Kindb.) Plants in dense, roundish, hoary cushions about 1 cm. high; upper leaves lanceolate, about 4 times as long as wide, with a long, whitish, denticulate hair-point ¾-2 times the length of the leaf; margins often plane or nearly so; dioicous; capsules cylindrical, smooth, brown, slightly constricted under the mouth when dry; calyptra campanulate-mitrate or cucullate, plicate, lobed or lacerate at base, covering the capsule nearly to the base; annulus none; teeth cribrose, papillose.

This is the commonest Grimmia of the dry rocky hillsides of the river canyons, replacing *G. montana* of the Arid Transition Zone on the plateau above. It has much the same macroscopic appearance, habit and habitat as *G. montana*, but is of a grayer color on account of the longer hyaline leaf-apices. Although both species not infrequently occur together, *G. calyptrata* may be easily distinguished by the conspicuous calyptra. This is described by Lesquereux & James as being campanulate-mitriform.[6] On many of the local specimens the calyptræ are cucullate, that is, hood-shaped and open on one side only. When flattened under a cover glass they show some resemblance to those in Sullivant's illustration.[7]

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[6] Lesquereux & James, Man. Mosses N. Am. 144, 1884.

[7] Sullivant, Icones Muscorum, 1: 69, t. 44, 1864.

Grimmia campestris Burch. (*G. leucophaea* Grev.) (*G laevigata* Brid.) Plants in dark green, hoary patches 1-2 cm. high; leaves broadly ovate or deltoid, not over 3 times as long as wide, terminating in a long, strongly spinulose-denticulate hair-point which usually about equals the length of the leaf-blade; lower cells rectangular, upper roundish-quadrate; dioicous; seta short, yellowish; capsule erect, cylindrical, smooth, reddish brown; calyptra mitrate; lid short beaked; annulus large; teeth orange, 2-cleft above the middle.

On basalt in the river canyons, fruiting in spring.

A form occurs in the Snake River Canyon at the mouth of Getta Creek, Idaho, (*Jones* 831), in which the hair-points of the leaves are much shorter and nearly smooth, and the leaf tips are closely imbricated, instead of spreading as is typical with the species.

Grimmia montana B.S.G. *Black Moss.* Plants densely pulvinate, 1-2 cm. high, hoary; leaves lanceolate, 1.5-2.2 mm. long, hair pointed; uppermost cells smaller, opaque, 2-stratose, dense, indistinct; lower cells rectangular, distinct; dioicous; seta short, yellowish, erect; capsule ovoid to cylindrical, smooth, reddish brown; lid obliquely beaked; teeth pale, irregularly cleft, slightly papillose.

G. montana is by far the most common species of Grimmia occurring in eastern Washington, being especially abundant on the basalt outcrops on the hillsides in the Palouse Country. It fruits from January to April or May, reaching its best development during February and March. By the end of April, growing conditions have become too dry and the plants lie dormant until the autumn rains stimulate them into new growth. This moss is one of the first plants to appear in a new association, and is often antecedent to the various foliose lichens. It is usually associated with *Tortula ruralis, Polytrichum piliferum* and *Camptothecium aeneum.*

GRIMMIA PSEUDO-MONTANA Card. & Ther. was collected by L. F. Henderson on dry rocks near Moscow, Idaho, in 1894. It is said to be allied to *G. montana* but "sufficiently distinct by the larger leaves, with a stouter nerve and a shorter and thicker hair, and chiefly by the peristomial teeth almost entire, not divided and scarcely perforated, with more numerous articulations".[8]

G. Doniana Sm. (listed as *G. Donii*) has been credited by Mrs. E. G. Britton to this area on the basis of a specimen collected by *Leiberg* at Spokane Falls in 1888.[9] This specimen, *Leiberg* 110, is better referred to *G. montana.*

Grimmia alpestris Schleich. Similar to *G. montana* but the lid is conical, and the hair-points of the leaves are shorter and nearly smooth.

Collected by *Sandberg, MacDougal & Heller* at Farmington Landing in 1892.[10]

Grimmia ovata Schwaegr. Plants in small tufts, dark or blackish green, somewhat hoary, 1.5-2.5 cm. high; leaves lanceolate, with a long, smooth hair-point, the lower ones small, muticous; basal cells narrow, incrassate, more or less sinuose, upper rounded-quadrate, 2-stratose; autoicous; seta erect, straight, yellowish; capsule exserted, ovoid, pale brown, smooth; calyptra mitrate; lid short beaked; teeth 2-3 cleft to the middle, orange, strongly papillose.

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[8] Bot. Gaz. 30: 14, 1900.

[9] Bull. Torr. Club 16: 106, 1889.

[10] Contr. U. S. Nat. Herb. 3: 370, 1896.

Granitic rocks, Moscow Mountain, *Pickett* 219.

Grimmia commutata Hueb. Plants dull or blackish green, in wide tufts 2-4 cm. high; leaves 2-2.5 mm. long, lanceolate, concave, with a long, stout, slightly spinulose hair-point; basal cells rectangular, upper cells roundish-quadrate, indistinct, 2-stratose; dioicous; seta erect, pale; capsule large, broadly ovoid, smooth, erect, dark brown; calyptra large, cucullate; teeth cribrose, 2-3 cleft to the middle, purplish, papillose.

On basalt in the Snake River Canyon, fruiting in spring.

5. HEDWIGIA.

Tufted, grayish green rupestral mosses; stems dichotomously branched, leafy; leaves oval, ecostate, hyaline tipped, 1-stratose; upper cells roundish-quadrate, papillose; perichætial leaves larger, erect, with longer points; seta very short; capsule immersed, upright, symmetrical; calyptra small, mitrate or cucullate, fugacious; lid short, obtuse; peristome none.

Hedwigia ciliata (Hedw.) B.S.G (*H albicans* Lindb.) Plants in loose spreading patches, glaucous or grayish green above, brownish or blackish below, brittle when dry; stems slender, leafless at base, with short lateral branchlets; leaves ovate, spreading, concave, with a wide hyaline spinulose or ciliate apex, imbricated when dry; margin recurved below; cells papillose, lower quadrate, upper ovate or hexagonal; capsule immersed, roundish-ovoid; calyptra subcucullate, fugacious; lid convex.

On basalt in the Snake River Canyon, fruiting in spring. Variable, especially as to leaf form, and presenting a very different appearance when moistened.

Family 9. FUNARIACEÆ.

Annual or biennial terrestrial mosses; stems short, erect; leaves broad, entire or serrate, the upper in rosettes; cells large, broad, parenchymatous, smooth, the upper hexagonal-rhomboidal; calyptra usually cucullate, long beaked, smooth; capsules various; peristome double, single, or absent; inner peristome usually distinct, lacking a basal membrane, segments opposite the teeth.

1. FUNARIA. Cord Moss.

With the general characteristics of the family.

Leaves acute; annulus large, revoluble; capsule furrowed when dry.

  Capsule horizontal or pendent .... *F. hygrometrica.*

  Capsule sub-erect .... *F convoluta.*

Leaves filiform-acuminate; annulus none; capsule nearly smooth .... *F americana.*

Funaria hygrometrica [L.—Sibth.] Hedw. Plants annual, pale green, in loose patches 0.5-1 cm. high; upper leaves clustered, concave, ovate-lanceolate, acute, entire or nearly so; seta 3-6 cm. high, twisted when dry, very hygroscopic, reddish, curved when young; capsule asymmetrical, pyriform, yellowish, horizontal or pendent, turgid, incurved at mouth, sulcate and brownish when dry; lid broad, convex, reddish; annulus large, revoluble; calyptra long beaked, cucullate; teeth obliquely arranged, united at apex; spores smooth.

On soil, etc., very common, fruiting in spring and early summer One of the first mosses to appear after a forest fire, when it is often associated with *Marchantia polymorpha.* Together, they frequently form a turf which may extend over a considerable area.

Funaria convoluta Hampe. Similar to *F. hygrometrica;* leaf margins involute; inner perichætial leaves convolute-clasping; capsule irregularly striate-costate when dry, sub-erect, attenuate at base.

Waitsburg, *Horner* 537, 540; Pullman, *Lawrence* 314.

Funaria americana Lindb. (*F. Muehlenbergii* Hedw. f.) Leaves long filiform-acuminate, with excurrent costæ; seta 1-1.5 cm. long; capsule arcuate, nearly smooth, rugulose at base; annulus none; spores papillose.

On moist banks, rare. Almota, *Piper* 249.

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RESEARCH STUDIES
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THE MOSS FLORA OF SOUTHEASTERN WASHINGTON AND ADJACENT IDAHO

PART 2

George Neville Jones

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THE MOSS FLORA OF SOUTHEASTERN WASHINGTON AND ADJACENT IDAHO*

PART 2

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Family 10. ORTHOTRICHACEÆ.

Arboreal or rupestral tufted mosses; stems erect or ascending, leafy, dichotomously branched; leaves more or less lanceolate, mostly entire, often papillose, very hygroscopic, appressed and imbricated or sometimes curled and twisted when dry; margins often revolute; costa well developed; upper cells small, usually papillose, thick-walled, opaque, roundish; basal cells rectangular or quadrate, thin-walled, pellucid; inflorescence autoicous or dioicous; capsules erect, symmetrical, cylindrical or pyriform, immersed, emergent or exserted, smooth or with 8 or 16 longitudinal striæ, often deeply furrowed when dry and old; stomata either superficial or immersed; lid beaked; annulus persistent or absent; peristome double, single or absent; teeth 16, lanceolate, papillose or striate, frequently arranged in pairs; inner peristome of 8-16 filiform or lanceolate processes which are alternate with the teeth; calyptra conical-mitrate, campanulate or cucullate, often plicate, smooth or villous.

Peristome none (*in our species*); calyptra cucullate........... 1. Zygodon
Peristome present; calyptra campanulate.... .... 2. Orthotrichum.

1. ZYGODON.

Plants yellowish green or blackish green; leaves narrowly lanceolate, papillose, twisted when dry, costate to the apex, upper leaves larger; capsule emergent or exserted, erect, urceolate or pyriform, with a distinct neck, 8-striate; lid obliquely beaked; calyptra cucullate, smooth; peristome none.

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* Contribution No. [illegible] from the Botany Department of the State College of Washington.

Zygodon lapponicus (Hedw.) B.S.G. (*Anoectangium lapponicum* Hedw.) (*Amphoridium lapponicum* Schimp.) Plants tufted, dark green, 1.5-3 cm. high; leaves narrowly lanceolate, strongly curled when dry, 1.5-2 mm. long; seta short, about 1.5 mm. long; capsule emergent, 8-striate, urceolate and contracted below the mouth when dry; lid red, shining, with a short oblique beak.

Crevices of rocks, rare.

2. ORTHOTRICHUM.

Arboreal or rupestral tufted or pulvinated mosses; leaves hygroscopic, not crisped when dry; capsules immersed, emergent or exserted, erect, usually cylindrical, often ribbed when dry; peristome single or double; teeth 16; inner peristome, when present, of 8-16 narrow processes, alternating with the teeth; calyptra campanulate-mitrate, often villous.

In the classification of the species of this genus, considerable importance often has been attached to the presence or the absence of processes or inner peristome. These processes are, however, often fragile and evanescent, and their absence does not necessarily mean that the peristome is single. All of our species are gymnoporous, *i.e.*, with the stomata superficial.

- Teeth erect or spreading when dry; rupestral.
  - Capsule ellipsoid-ovoid, immersed or emergent.................. O. *rupestre*.
  - Capsule cylindrical, exserted.................................. O. *Macounii*.
- Teeth reflexed or revolute when dry.
  - Capsule exserted, smooth or faintly ribbed when dry and empty; rupestral.................................. O. *speciosum*.
  - Capsule immersed or emergent when moist, strongly ribbed when dry and empty; arboreal.................................. O. *affine*

Orthotrichum rupestre Schleich. Plants in loose tufts, dark brownish when dry, with spreading stems 2-5 cm. long; leaves lanceolate, acute; cells roundish-hexagonal, incrassate, papillose, opaque; capsule immersed or emergent, ellipsoid-ovoid, short necked, yellowish brown, ribbed when dry; stomata superficial, most prevalent near the middle of the capsule; teeth in pairs, yellowish white, erect or spreading when dry, slightly papillose; processes more or less developed, fugacious, yellowish, papillose; calyptra more or less villous to nearly glabrous.

On rocks, common, especially in the river canyons.

The var. *Sturmii* Juratz. apparently occurs here, but the characters are so intangible that it seems better to include it with the species rather than to retain it separately as a variety.

Orthotrichum Macounii Aust. Plants in dense roundish tufts, yellowish green or brownish green; stems 1-2.5 cm. high; leaves lanceolate, acuminate, papillose; margins revolute; capsule pale, cylindrical, exserted, smooth or faintly short ribbed; stomata superficial; teeth 16, in pairs, erect or spreading when dry, papillose; processes 8 or none; calyptra more or less villous.

On rocks, not uncommon.

var. **Roellii** (Venturi) comb. nov. *O. Roellii* Venturi, Bot. Cent. 44: 416, 1890. Very similar to *O. Macounii* but the peristome teeth are striolate, not papillose.

On rocks, more common than the species. As this plant occurs with *O. Macounii*, has no distinct range, and seems to have no other character than the striolate teeth to distinguish it, it seems better to treat it as a variety of *O. Macounii.*

Orthotrichum speciosum Nees. Stems 2-3.5 cm. high; plants yellowish green above; leaves lanceolate, acute; upper cells incrassate, papillose; margins recurved; costa percurrent; capsule cylindrical, emergent or exserted, smooth or ribbed in the upper half when dry; stomata superficial; teeth in pairs, recurved, with the tips touching the capsule when dry; processes usually 8, papillose; calyptra cylindrical-oblong, villous.

On rocks and bases of trees.

var. **elegans** (Schwaegr.) Broth. is a smaller, more slender plant with a shorter, nearly smooth calyptra; teeth reflexed against the capsule.

On rocks, Moscow Mountain, *Jones* 2088.

Orthotrichum affine Schrad. Plants in loose, brownish green tufts; stems 1-2 cm. high; leaves lanceolate, acute or acuminate, papillose; margins recurved; capsules emergent when moist, cylindrical, contracted below the mouth, 8-ribbed when dry and empty; stomata superficial; calyptra pale, cylindrical-campanulate, sparsely villous; *teeth papillose, reflexed or revolute when dry;* processes 8.

On bark of trees and shrubs, Almota Canyon, *Pickett* 657.

var. **fastigiatum** Hueb. Very similar to *O. affine;* plant smaller; capsule immersed when moist; teeth striolate.

Common on the bark of trees and shrubs.

ORTHOTRICHUM IDAHENSE Card. & Ther. Bot. Gaz. 30: 19, 1900. Type locality, Idaho: Moscow Mountains, on rock. Collected by L. F. Henderson in 1893. This seems to be related to *O. affine*, but no specimens have been examined by the author.

Family 11. BARTRAMIACEÆ.

Large, tufted, pale green mosses; leaves lanceolate or narrower, acute, toothed above the middle; cells parenchymatous, elongate-rectangular, mostly papillose; costa slender, percurrent or excurrent; calyptra small, cucullate, fugacious; capsule globose or nearly so, upright, exserted, striate or ribbed in age; lid small, short beaked; peristome usually double, sometimes single or absent.

Peristome absent; leaves linear-lanceolate .... 1. ANACOLIA.
Peristome present.
  Leaves linear-lanceolate .... 2. BARTRAMIA.
  Leaves ovate or lanceolate .... 3. PHILONOTIS.

1. ANACOLIA.

Robust, tufted, brownish green mosses; leaves 8-seriate, crowded, lanceolate, serrate; costa single, strong, prominent on lower surface of leaf; cells thick-walled, mostly quadrate or rectangular; seta short, upright; capsule upright, symmetrical, more or less spheroidal, striate when dry and empty; peristome usually absent; lid convex.

Anacolia Menziesii (Turn.) Paris. (*Bartramia Menziesii* Turn.) Plants in loose tufts, 3-8 cm. high, branched, brown and radiculose below the middle, yellowish green above; leaves linear-lanceolate, subulate, 2-3 mm. long, serrate above the middle from an ovate base; margins recurved; costa prominent; capsule erect, ovoid, wrinkled when dry; seta slender, 1-1.5 cm. long; lid conical; peristome none or rudimentary.

Common on soil on moist basaltic ledges, especially in the river canyons, fruiting in May and June.

2. BARTRAMIA.

Plants densely tufted, erect; stems dichotomously branched; leaves narrow, usually papillose; cells small, rectangular; capsule more or less spheroidal, striate or sulcate when dry; peristome usually double.

Bartramia pomiformis [L. ex p] Hedw., var. **crispa** [Sw.] B.S.G. *Apple Moss* Plants in loose, soft, yellowish green or light green tufts 5-8 cm. high; leaves numerous, linear, serrate, acuminate, 4-5 mm. long, somewhat curled when dry; margins recurved; costa shortly excurrent, spinulose; basal cells linear, hyaline; upper cells papillose, elliptical or rounded; seta erect, 1-1.5 cm. long; capsule globose, cernuous, about 2 mm. in diameter, deeply sulcate when dry.

Collected at Farmington Landing by *Sandberg, MacDougal & Heller* in 1892.

3. PHILONOTIS.

Large palludal mosses, producing whorled innovations below the inflorescence; stems tall, slender, branched, radiculose below; leaves short, serrate, mostly acute or acuminate, ovate or lanceolate; cells usually papillose; capsules ovoid or globose, cernuous; peristome double.

Philonotis fontana [L.] Brid. Plants in loose wide tufts, pale or yellowish green; stems slender, fragile, red, branched, 5-15 cm. high, radiculose below; leaves ovate-lanceolate, acuminate, more or less plicate, denticulate; margins revolute; costa well developed, sometimes papillose, more or less excurrent; cells papillose, rectangular below, linear-vermicular above; seta erect, slender, red or yellowish, 1-4 cm. long; capsule ovoid or globose, cernuous, curved, brown when mature, striate; lid convex, red.

Swamps, common and variable, fruiting in summer.

Family 12. AULACOMNIACEÆ.

Rupestral, terrestrial or arboreal mosses of moist habitats; leaves 8-seriate, usually serrate at least at apex, costate; cells small, rounded, mostly papillose; capsules exserted, cernuous, ribbed when dry; calyptra cucullate, beaked, fugacious; peristome bryoid; inner and outer peristomes of equal length.

1. AULACOMNIUM.

Tufted mosses growing on soil or decaying wood, frequently bearing pseudopodia; leaves ovate or oblong-lanceolate; cells small, roundish or hexagonal, each bearing a large rounded papilla on its surface; seta erect, mostly long and slender; capsule cylindrical, often somewhat curved, with 8 longitudinal ribs, sulcate when dry; calyptra long beaked, cucullate.

Aulacomnium androgynum [L.] Schwaegr. Plants loosely tufted, 2-3.5 cm. high, dull green; stems slender, erect, frequently bearing slender pseudopodia with terminal round clusters of gemmæ; leaves ovate-lanceolate or linear-lanceolate, 1-2 mm. long, slightly twisted when dry; margins reflexed near base, denticulate near apex; cells thickened, roundish-quadrate, each bearing a large conical papilla on its surface; seta erect, slender, 1.5-2 cm. long; capsule erect or ascending, symmetrical, almost straight, brown, ribbed or sulcate when dry.

On decaying wood, common, seldom fruiting.

Family 13. TIMMIACEÆ.

Large mosses somewhat with the aspect of *Polytrichum*, dark green; stems simple or slightly branched; leaves linear-lanceolate, serrate; costa slender, percurrent or shortly excurrent; cells linear or elongate-rectangular at base of leaf, roundish-hexagonal above; capsule horizontal or ascending, cylindrical or clavate, furrowed when dry; lid convex or short beaked; calyptra narrow, cucullate; peristome double, outer teeth densely articulate, the inner with cilia in pairs or 4's, *opposite to the teeth, from a basal membrane.*

1. TIMMIA.

With the general characteristics of the family.

Timmia austriaca Hedw. Plants densely tufted, 5-10 cm. high, radiculose near base; leaves 4-6 mm. long, from an orange-colored sheathing base, twisted when dry, erect-spreading when moist, linear-lanceolate, serrate to the middle; costa strong, percurrent, often dentate on the back near apex; basal cells orange-tinted, elongate-rectangular, pellucid; upper cells small, roundish-quadrate; capsule horizontal, clavate, furrowed when dry; seta erect, slender; lid apiculate; teeth pale yellow, papillose; calyptra cucullate.

On soil and rocks in woods, not uncommon.

A stunted form that frequently occurs among the typical ones has been named var. *brevifolia* Ren. & Card., but it seems to be scarcely worth nomenclatorial recognition.

Family 14. BRYACEÆ.

Terrestrial or rupestral tufted mosses; leaves reduced below, smooth, mostly 1-stratose; costa percurrent or more or less excurrent; seta erect, smooth, elongated; capsule smooth, usually pendent, symmetrical or nearly so; calyptra cucullate, fugacious; lid short pointed or rarely beaked; peristome double; outer teeth entire, lanceolate, articulate; inner teeth thin, pale, alternating with the outer; intermediate cilia present or absent.

Upper cells parenchymatous, more or less hexagonal; male flowers with clavate paraphyses.......... 1. MNIUM.
Upper cells prosenchymatous, often elongated; male flowers with filiform paraphyses.
  Leaves subulate.......... 2. LEPTOBRYUM.
  Leaves not subulate.
    Cells narrowly rhomboidal to linear.......... 3. WEBERA.
    Cells widely rhomboidal to hexagonal-rhomboidal.......... 4. BRYUM.

1. MNIUM.

Tall, terrestrial, sylvan mosses with large, pellucid, frequently bordered leaves; cells rounded or quadrate-hexagonal, smooth; costa stout; capsules pendent or horizontal, cylindrical or ellipsoidal; calyptra cucullate.

Leaves entire.......... *M. punctatum.*
Leaves singly or doubly serrate.

- Leaves doubly serrate, *i.e.*, teeth in pairs.
  - Costa spinulose on the back........ *M. orthorrhynchum.*
  - Costa not spinulose on the back.
    - Leaves obovate to spatulate........ *M. spinulosum.*
    - Leaves oblong-lanceolate........ *M. serratum.*
- Leaves simply serrate.
  - Leaves not bordered........ *M. acanthoneuron.*
  - Leaves bordered with narrow cells.
    - Capsule papillose at base; synoicous........ *M venustum.*
    - Capsule smooth at base.
      - Dioicous; teeth of leaves many, slender, usually of more than 2 cells........ *M. affine.*
      - Synoicous; teeth of leaves few, short, usually of less than 2 cells........ *M. medium.*

Mnium punctatum [L.] Hedw. Plants stout, dark green, branched, 7-10 cm. high, with reddish or brownish radicles; leaves broadly obovate, emarginate or apiculate, 6-8 mm. long, 4-5 mm. wide, entire; seta erect, slender, pale, 2-4 cm. long; capsule ellipsoidal, horizontal or pendent; lid beaked; teeth yellowish, papillose; inflorescence dioicous.

On logs, rocks or soil in moist woods, especially along streams, fruiting in spring or early summer.

Mnium orthorrhynchum B.S.G. Stems erect, 3-5 cm. high; leaves oblong-lanceolate, 4-5 mm. long, doubly serrate, spinulose on back near apex; cells 12-18 microns in diameter, not strongly collenchymatous, hexagonal; capsule usually solitary, horizontal or pendent, ellipsoidal, 4-5 mm. long; seta 1.5-2.5 cm. long; inflorescence dioicous; lid beaked.

On rocks and soil in woods, fruiting in late summer and autumn.

Mnium spinulosum B S.G. Plants loosely tufted, dark green; stems slender, 1.5-3 cm. high; leaves obovate to spatulate, decurrent, mostly clustered at the top of the stem, acute, doubly serrate above the middle; capsule yellowish, horizontal or pendent, ellipsoidal; lid beaked; peristome reddish brown; inflorescence synoicous.

On decaying wood, common, fruiting in summer.

Mnium serratum [Schrad.] Schwaegr. (*M. marginatum* Beauv.) Plants slender, 2-4 cm. high, dark green or reddish tinged; leaves ovate, obovate or spatulate, acute, decurrent, red bordered, 4-5 mm. long; seta 2-3 cm. long; capsule usually solitary, cylindrical or ellipsoidal, 4-5 mm. long; lid beaked; inflorescence synoicous.

On moist rocks in the mountains, rare, fruiting in spring or early summer.

Mnium acanthoneuron (Schwaegr.) comb. nov. *Hypnum acanthoneuron* Schwaegr. Suppl. Hedw. Sp. Musc. 3, pt. 2, 1, t. 258, 1827. *Bryum Menziesii* Hook. Bot. Misc. 1: 36, t. 19, 1830. *Rhizogonium acanthoneuron* C. Muell. Bot. Zeit. 803, 1847. *Mnium Menziesii* C. Muell. Syn. 1: 177, 1849. Plants erect, dendroid, 6-10 cm. high, with numerous brownish rhizoids at base, branched at the summit; stem leaves remote, appressed, scale-like; branch leaves ovate-lanceolate, acute, sharply serrate, not bordered; costa single, subpercurrent, spinulose on the back; perichætial leaves filiform-acuminate; capsules 1-3 together, cylindrical, pendent, brown, 5-6 mm. long; setæ erect, slender, 3.5-4.5 cm. long.

On decaying logs or moist soil in deep shady woods, not common.

Mnium venustum Mitt. Plants erect, leafy, pale green, 4-6 cm. high; leaves elliptical, acuminate, serrate, teeth short, usually consisting of less than 2 cells; capsules usually clustered, cylindrical, pendent, 4-5 mm. long, papillose at base; lid conical.

In woods, rare, Spokane County and northern Idaho.

Mnium affine [Bland.] Schwaegr. Plants loosely tufted, pale green, radiculose below, 5-8 cm. high; leaves ovate or oblong-elliptical, simply serrate, somewhat acute, 5-7 mm. long, cuneate and decurrent at base, crisped when dry, bordered with linear cells; capsules 2-4 together, pendent, ellipsoidal or cylindrical, 4-8 mm. long; setæ erect, slender, 2.5-3.5 cm. long; lid apiculate.

On moist ground in woods, fruiting in spring or frequently sterile.

Mnium medium B.S.G. Plants 3-8 cm. high, radiculose at base; leaves broadly ovate-lanceolate, 6-8 mm. long, bordered, simply serrate; setæ orange, 3-6 cm. long; capsules 2-5, ellipsoidal or cylindrical, pendent, 4-5 mm. long, yellowish brown; lid short beaked.

On moist rocks and logs in woods, fruiting in spring. Very similar to *M. affine*.

2. LEPTOBRYUM.

Closely related to *Bryum*. Stems erect, slender, annual; leaves subulate; cells linear; capsule pyriform, pendent, long necked; peristome as in *Bryum*.

Leptobryum pyriforme [L.] Wils. *Long-necked Bryum*. Plants tufted, yellowish green, shining; stems slender, erect, 1-2.5 cm. high; leaves subulate, flexuose, 2-3 mm. long, denticulate near apex, lower ones shorter; costa broad, slightly excurrent; cells linear; seta erect, slender, flexuose, 2.5-5 cm. long, brownish, shining; capsule pendent or horizontal, pyriform, long-necked, reddish brown, shining; teeth yellow, papillose.

On moist rocks, damp soil or decaying wood, fruiting in summer.

3. WEBERA.

Differing from *Bryum* in its narrower leaves and areolation and the non-appendiculate cilia; costa sub-percurrent in our species.

Plants usually dark green, 1-2 cm. high; median leaf cells rhomboidal, 7-10:1 .... *W. nutans.*

Plants pale or glaucous green, 2.5-5 cm. high; median cells linear-vermicular, 10-15:1 .... *W. cruda.*

Webera nutans [Schreb.] Hedw. (*Pohlia nutans* Lindb.) Plants tufted, dark green; stems 1-2 cm. high; leaves ovate, or the upper lanceolate or linear-lanceolate, acute, denticulate near apex; costa strong, reddish; cells long-rhomboidal, 7-10:1; setæ erect, slender, flexuose, 2-4 cm. long; capsules pendent, obovoid or cylindrical, reddish brown, 3-4 mm. long; lid conical, apiculate; peristome yellow; basal membrane of the inner peristome about ⅓-½ the length of the teeth.

On soil, decaying wood, etc., in woods, common and variable.

Webera cruda [L.] Schwaegr. (*Pohlia cruda* Lindb.) Plants pale or glaucous green, 2.5-5 cm. high; lower leaves ovate, upper lanceolate, acute, denticulate near apex; costa reddish; median cells linear-vermicular, 10-15:1; setæ erect, slender, flexuose, 3-5 cm long; capsules mostly horizontal, cylindrical, reddish brown, 3-4 mm. long; lid conical, apiculate; peristome yellow; basal membrane of the inner peristome about ½ the length of the teeth.

On soil and basalt outcrops usually near springs or wet places on hillsides where it is common in early spring and usually sterile. It is often associated with *Bryum caespiticium*

4. BRYUM.

Tufted, dichotomously branched, terrestrial mosses; leaves thin, ovate or lanceolate, acute, frequently bordered with linear cells; cells rhomboidal, smooth; costa percurrent or excurrent; calyptra cucullate, evanescent; capsule pyriform or cylindrical, pendent; lid conical; outer peristome of 16 lanceolate, entire, articulated teeth; inner peristome of 16 pale, lanceolate processes, alternating with the teeth and joined by a basal membrane in the lower half; cilia 1-3, appendiculate, or rudimentary or none.

A very large and difficult genus with over 900 species occurring throughout the world.

Plants silvery white; costa sub-percurrent .... *B. argenteum.*

Plants green.

Cilia absent or rudimentary; costa excurrent; capsule 2-3 mm. long .... *B. inclinatum.*

Cilia present.

Costa sub-percurrent; cilia non-appendiculate; capsule 5-7 mm. long .... *B. lucidum.*

Costa percurrent or excurrent; cilia appendiculate.

Capsule 4-5 mm. long; leaves widest above the middle .... *B. capillare.*

Capsule 2-3 mm. long; leaves widest about or below the middle.
  Synoicous.. *B. pseudo-triquetrum.*
  Dioicous... *B. caespiticium.*

Bryum argenteum [L.] Hedw. *Silvery Bryum.* Plants tufted, 1-2.5 cm. high, pale green or silvery white; stems slender, terete, julaceous; leaves imbricated, ovate, concave, entire, often hyaline above; costa not reaching apex; seta erect, short, 1 cm. long; capsule cylindrical, pendent, 1.5-2 mm. long, reddish brown; lid conical; teeth orange.

Moist soil in open places, fruiting in autumn.

Bryum inclinatum Bland. Plants closely and densely tufted; leaves ovate-lanceolate, acuminate, usually widest about the middle, entire or nearly so; margins reflexed; costa excurrent; inflorescence synoicous or autoicous; seta erect, slender, 2-4 cm. long; capsule pyriform, pendent, 3 mm. long; lid apiculate; spores yellowish green or brownish, 18-25 microns in diameter; teeth often deep red, especially at base; cilia none or rudimentary.

On soil on basalt ledges.

Bryum lucidum E. G. Britt. (*Roellia lucida* Kindb.) Plants stoloniferous, in loose, light green tufts; stems 4-angled, black, erect, simple, radiculose at base, 1-3 cm. high; lower leaves reduced, appressed, upper leaves rosulate, 3-5 mm. long, elliptical, acute, denticulate near apex, entire below, bordered with narrow cells; costa sub-percurrent; cells chlorophyllose, the upper elongate-hexagonal, the lower rectangular; seta solitary, erect, 3-5 cm. long, brown, smooth, shining; capsule usually horizontal, cylindrical, 5-7 mm. long; cilia 3-4, non-appendiculate, faintly papillose; lid apiculate; inflorescence dioicous.

On moist ground in coniferous woods in the mountains.

Bryum capillare [L.] Hedw., var **torquescens** (B.S.G.) Husn. Plants tufted, 1-4 cm. high; leaves obovate-spatulate; capsule reddish brown, elongate-pyriform, pendent, 4-5 mm. long; lid apiculate; cilia present, appendiculate; inflorescence synoicous.

On rocks, not common.

Bryum pseudo-triquetrum (Hedw.) Schwaegr., ssp. **affine** (Bruch) Dixon, var. **cirratum** (Hornsch.) Braithw. (*B. cirratum* Hornsch.) Plants in thick tufts 1-3 cm. high; stems often with long slender leafy innovations; leaves ovate, acuminate; capsule elongate-pyriform, pendent, 2-3 mm. long; lid apiculate; cilia present, appendiculate; inflorescence synoicous.

Moist ground and rocks, not common.

Bryum caespiticium [L.] Hedw. Plants densely tufted, slender, yellowish green, 1.5-2.5 cm. high; leaves oblong-lanceolate, acuminate, usually widest below the middle, sometimes more or less bordered; costa long excurrent; inflorescence dioicous; seta erect, 2-3 cm. high; capsule pyriform, pendent, 3 mm.

long; lid conical; spores yellow, 10-14 microns in diameter, maturing in spring; cilia 2-3, appendiculate.

On moist rocks and soil, common. Abundant in swampy places on hillsides in early spring.

There are probably several other species occurring in this region, but owing to the almost invariable absence of fruit, their exact determination is not possible.

Family 15. LESKEACEÆ.

Mosses of various habit, growing on rocks, trees or soil; leaves various, papillose; costa double, single or absent; cells roundish or rhomboidal to linear-vermicular; capsules symmetrical, erect or curved, long-ovoid or cylindrical; calyptra cucullate; peristome hypnoid.

Plants glaucous green, slender, julaceous; costa indistinct. 1. MYURELLA.
Plants not glaucous or julaceous.
  Costa short and weak, reaching to middle of leaf or below; cells linear-rhomboidal; seta arising from main stem; paraphyllia none; capsule erect 2. PTERIGYNANDRUM.
  Costa strong, reaching above middle of leaf.
    Cells rounded; stems stoloniferous; paraphyllia none; seta arising from a secondary stem; capsule erect 3. ANOMODON.
    Cells oval or rhomboidal; capsule curved or inclined; paraphyllia usually present.
      Leaves imbricated when dry; paraphyllia usually numerous 4. PSEUDOLESKEA.
      Leaves crisped and curled when dry; paraphyllia few or none 5. CLAOPODIUM.

1. MYURELLA.

Glaucous, slender, fragile, rupestral mosses with irregularly branched, julaceous stems; leaves imbricated, roundish, concave; costa short, double, indistinct; cells loose, small, roundish-rhomboidal; capsule small, erect, symmetrical; lid conical; calyptra small, cucullate; annulus present; peristome perfect.

Myurella julacea (Vill.) B.S.G. Plants slender, glaucous green, or when dry whitish, 4-6 cm. long, spreading; leaves imbricated, roundish, ovate, obtuse or apiculate, denticulate; cells mostly oval-rhomboidal; capsule erect or nearly so, obovoid or ellipsoidal, on a slender seta; lid conical.

On rocks, not common, usually sterile in this area.

2. PTERIGYNANDRUM.

Primary stems creeping, stoloniferous, radiculose; secondary stems ascending, irregularly branched, leafy, arcuate; leaves ovate, imbricated, crowded, acute, papillose on back; margins somewhat revolute, serrate above; costa short and weak; cells mostly linear-rhomboidal, or quadrate in the basal angles; inflorescence dioicous; capsule erect, symmetrical, cylindrical; lid short beaked; calyptra cucullate; teeth articulate, outer ones short.

Pterigynandrum filiforme (Timm) Hedw. Plants in spreading mats, olive or yellowish green; stems stoloniferous with numerous slender, curved branches; leaves oblong or ovate, acute, concave, denticulate at apex; costa weak, short, single or double; cells at base quadrate; upper cells linear-vermicular or rhomboidal, all papillose on back; seta slender, erect, yellowish, about 1.5 cm. long; capsule erect, cylindrical; lid beaked; calyptra smooth, cucullate.

On rocks and bases of trees, fruiting in summer or frequently sterile.

3. ANOMODON.

Bright green, loosely tufted mosses with stoloniferous stems; leaves ovate or lanceolate, 5-ranked, thickish, usually with flat and entire margins; paraphyllia none; cells roundish or hexagonal, papillose on both sides; costa single, reaching above the middle of the leaf; capsule erect, symmetrical, cylindrical; calyptra smooth, cucullate; lid beaked; peristome double; outer teeth lanceolate, papillose; cilia of inner peristome obsolete or nearly so.

Anomodon viticulosus [L.] Hook. & Tayl. Plants bright or yellowish green when moist, growing in large loose tufts; stems spreading, somewhat branched, 5-10 cm. long; leaves more or less secund, crisped when dry, thick and soft in texture, pale green, lanceolate or oblong-lanceolate, obtuse, 3-4.5 mm. long, denticulate at apex; costa strong, ceasing below apex, whitish when dry; cells hexagonal, strongly papillose; basal cells rectangular; seta erect, yellowish, about 2 cm. long; capsule smooth, erect, cylindrical, 2-3 mm. long, with dark colored, longitudinal lines; lid short beaked.

On bases of trees, Seven Sisters Springs, Blue Mountains, Asotin Co., Wash. The only known station for this plant in western United States.

4. PSEUDOLESKEA.

Bright green or brown, usually rupestral mosses; stems slender, irregularly branched, not stoloniferous; paraphyllia numerous; leaves ovate-lanceolate, acute; costa single, extending above middle of leaf; cells quadrate-hexagonal to linear rhomboidal, or at base rectangular;

capsule erect, horizontal or curved; calyptra cucullate; peristome well developed.

Pseudoleskea atrovirens (Dicks.) B.S.G. Plants in large, loose, green or brownish mats; stems creeping, irregularly branched, 3-5 cm. long; leaves falcate, ovate-lanceolate, acuminate, denticulate near apex; cells oval-rhomboidal above, rectangular below, all more or less papillose on both surfaces; costa strong, reaching to near apex; seta erect, 8-10 mm. long, brownish red; capsule cylindrical, curved; lid conical; teeth yellow; cilia obsolete or nearly so; spores rough, brown.

On rocks and bases of trees. A form with less papillose and slightly longer-acuminate leaves is by some botanists considered distinct under the name *P. oligoclada* Kindb.

Pseudoleskea pallida Best. Plants in denser, olive green tufts and the leaves smooth or papillose only on the upper surface.

Moscow Mountain, *Jones* 848.

5. CLAOPODIUM.

Plants robust to slender, yellowish green to brownish, not shining; stems spreading, sometimes stoloniferous; paraphyllia few; leaves crisped when dry, lanceolate, mostly with plane margins, serrate above the middle, sometimes hair-pointed; branch leaves similar, with shorter points; costa single, strong, extending to near apex; cells roundish-quadrate or roundish-oval, elongated at base of leaf near the costa, papillose; seta slender, reddish, smooth or rough; capsule horizontal or curved, unsymmetrical, ovoid-cylindrical, brown, short-necked; peristome teeth yellow, lanceolate, bordered, transversely striate; inner peristome smooth or slightly papillose; cilia 1-3, nodose; lid conical or rostrate.

Leaf cells unipapillate.. *C. crispifolium.*
Leaf cells each with 2-5 papillae.................................. *C. Bolanderi.*

Claopodium crispifolium (Hook.) Ren. & Card. Plants slender, pinnately and bi-pinnately branched, yellowish brown when dry; stems 5-8 cm. long; leaves crisped when dry, ovate-lanceolate, acuminate to a filiform, hyaline apex; margins plane, serrulate; costa strong, extending ⅔ the length of the leaf; cells roundish-quadrate, stoutly unipapillate, elongated at base near costa; seta rough, 2.5-3 cm. long; capsule narrowly ovoid-cylindrical, horizontal.

On soil and rocks in woods.

Claopodium Bolanderi Best. Similar to *C. crispifolium* but smaller; stems 3-5 cm. long; leaf cells pluripapillate with 2-5 small papillae to each cell; seta 1.5-2 cm. long; capsule broadly ovoid to sub-globose.

On rocks and soil in woods, common. Often growing with *Eurhynchium pulchellum*, from which it may be readily distinguished by its hyaline pointed leaves which are crisped when dry.

Family 16. HYPNACEÆ.

Pleurocarpous mosses with creeping, ascending or erect, variously branched stems; leaves variable, usually thin, frequently glossy, seldom crisped when dry; cells 2-10 times as long as wide, from linear-vermicular to shortly rhomboidal, mostly smooth, seldom slightly papillose; costa single, double or none; capsule exserted, often curved, occasionally erect; peristome usually perfect; teeth 16, lanceolate-subulate, hygroscopic, usually transversely striate on the basal joints; inner peristome arising from a basal membrane; cilia 1-3 or none; calyptra cucullate, smooth.

- Costa usually single, reaching to middle of leaf or beyond.
  - Plants of a more or less dendroid habit, erect or ascending, leafless below, branched above.
    - Capsule erect and symmetrical; cilia none. (*Climacieae*) .... 1. CLIMACIUM.
    - Capsule cernuous; peristome perfect. (*Porotricheae*) .. 2. POROTRICHUM.
  - Plants not dendroid.
    - Capsule not strongly contracted below the mouth when dry; seta usually papillose. (*Brachythecieae*)
      - Lid usually long-beaked; leaves smooth or faintly plicate.
        - Leaves not cochleariform or abruptly filiform-acuminate .... 3. EURHYNCHIUM.
        - Leaves cochleariform, abruptly filiform-acuminate 4. CIRRIPHYLLUM.
      - Lid conical to short-beaked (except 1 sp. of *Brachythecium*); leaves strongly plicate.
        - Capsule ellipsoidal; median cells long-rhomboidal.. 5. BRACHYTHECIUM.
        - Capsule cylindrical; median cells linear........ 6. CAMPTOTHECIUM.
    - Capsule usually contracted under the mouth when dry and empty; seta usually smooth. (*Amblystegieae*)
      - Median leaf cells long-rhomboidal, usually less than 5:1 .... 7. AMBLYSTEGIUM.
      - Median leaf cells linear, 10-30:1 .... 8. DREPANOCLADUS.
- Costa usually short and double or obsolete. (*Hypneae*)
  - Capsule cylindrical, with a thin pericarp; cilia nonappendiculate, sometimes absent.
    - Leaves complanate; paraphyllia none .... 9. PLAGIOTHECIUM.

Leaves usually falcate-secund; paraphyllia usually present..10. HYPNUM.

Capsule short and thick, ovoid-ellipsoidal, with a thick pericarp; cilia present, mostly appendiculate; paraphyllia usually present..11. HYLOCOMIUM

1. CLIMACIUM. TREE MOSS.

Main stems creeping, stoloniferous, rhizome-like, radiculose; secondary stems erect, dendroid, leafless below, branched above; branches leafy, paraphyllose; leaves oblong-lanceolate, plicate; costa single, extending nearly to apex of leaf; cells smooth, rhomboidal or linear; inflorescence dioicous; capsule cylindrical or ellipsoidal; seta long and slender; peristome large, double; teeth papillose, articulate, reddish, narrowly lanceolate; inner peristome yellow, papillose, from a short basal membrane; cilia obsolete or rudimentary; calyptra cucullate.

Median cells of the branch leaves 5-7:1; branch leaves closely imbricated; capsule about 6 mm. long........................ *C americanum*

Median cells of the branch leaves 8-12:1; branch leaves loosely imbricated; capsule about 4 mm long........................ *C dendroides*

Climacium americanum Brid. Plants 5-7 cm. high; branch leaves closely imbricated, decurrent and auriculate, acute, serrate near apex, 2 mm. long; median cells oblong-rhomboidal, 5-7:1; capsule erect, 6-7 mm. long; lid beaked.

In damp woods, rare, fruiting in autumn and winter.

Climacium dendroides [L.] Web. & Mohr. Very similar to *C. americanum;* plants 7-10 cm. high; branch leaves loosely imbricated; median cells linear rhomboidal, 8-12:1; capsule about 4 mm. long.

In similar habitats.

2. POROTRICHUM.

Robust mosses with primary stems creeping, radiculose, stoloniferous, with scale-like leaves; secondary stems erect or ascending, unbranched below, stout, dendroid above; branches flattened, curved, more or less turned to one side; leaves unsymmetrical, oblong to ovate, serrate; costa strong, single; cells thick walled, oval or rounded, the basal longer and narrower; capsule either erect or inclined, ellipsoidal or cylindrical; peristome perfect; teeth more or less papillose, lanceolate to linear, yellowish; inner peristome from a wide basal membrane; cilia 3, appendiculate, between the processes or sometimes absent; annulus revoluble; lid beaked; calyptra cucullate, usually glabrous.

Porotrichum neckeroides (Hook.) Williams. (*Hypnum neckeroides* Hook.) (*Thamnium Leibergii* E. G. Britt.) Secondary stems erect or ascending; leaves ovate, obtuse, sharply serrate at apex, 2-3 mm. long; costa stout, extending nearly to apex of leaf, dentate on back in upper half; apical and median cells hexagonal or quadrate; basal cells rectangular or oblong; "capsules oblong-ovate, cernuous; peristome perfect".[11]

In woods, Moscow Mountain, *Jones* 2075 (sterile).

3. EURHYNCHIUM.

Mosses of various habit; stems prostrate; branch leaves ovate or deltoid, serrate, tapering from the middle; median cells linear, 8-12:1, those at the apex sometimes broader and shorter; costa single, reaching to the middle of the leaf or beyond; lid usually long beaked.

Apical cells of the branch leaves broader and shorter than the median; seta smooth.
  Branch leaves 0.6-0.9 mm. long .... *E. pulchellum.*
  Branch leaves 1-1.5 mm long .... *E. fallax.*
Apical cells of branch leaves not differentiated from the median; seta papillose.
  Stems slender, irregularly branched; branch leaves not over 1 mm. long .... *E. praelongum.*
  Stems robust, regularly pinnately branched; branch leaves 1-1.5 mm. long .... *E. oreganum.*

Eurhynchium pulchellum (Hedw.) Jennings. (*Hypnum pulchellum* Hedw.) (*E. strigosum* [Hoffm.] B.S.G.) Plants in loose spreading mats or tufts, bright green; stems prostrate or ascending, radiculose, stoloniferous, 5-10 cm. long; branch leaves ovate-lanceolate, acute or obtuse, serrate, 0.5-1 mm. long; margins plane; median cells linear; apical cells broader and shorter; seta erect, smooth, reddish brown, 1-2 cm. long; capsule inclined or horizontal, ellipsoidal-cylindrical; lid long beaked; cilia 2-3; spores nearly smooth, 10-12 microns in diameter, maturing in autumn.

On soil, bases of trees and bushes and on decaying logs in moist woods and thickets, common. Very variable as to leaf shape.

var. **praecox** (Hedw.) comb. nov. *Hypnum praecox* Hedwig. Sp. Musc. 249, pl. 64, 1801. *E. strigosum* [Hoffm.] B.S.G., var. *praecox* (Hedw.) Husnot, Musc. Gall. 332, 1893. This variety has erect, julaceous branches and imbricated, more crowded leaves. Frequently found with the species.

Eurhynchium fallax (Ren. & Card.) Grout. Similar to *E. pulchellum*; branch leaves strongly decurrent, ovate-lanceolate or lingulate, 1-1.5 mm. long, obtuse.

11. Grout, Moss Fl. N. Am. 3, pl. 1: 1, 1931.

in similar habitats. While this species is not definitely known to occur in our limits, the var. **Barnesii** (Ren. & Card.) Grout, is not uncommon. This variety is stouter, with longer, thicker capsules and lingulate leaves.

Eurhynchium praelongum [L.] Hobk. (*Hypnum praelongum* L.) Plants in spreading tufts; stems slender, prostrate, irregularly branched, 3-10 cm. long; branch leaves ovate-lanceolate, acuminate, denticulate, not over 1 mm. long; apical and median cells not differentiated, linear, 10-18:1; seta papillose, 1.5-2.5 cm. long; capsules horizontal, brown, ellipsoidal or cylindrical; lid long-beaked; cilia 2.

On soil or decaying logs in woods and thickets.

var **Stokesii** (Turn.) Hobk. A variety occurring with the species that has stouter regularly pinnately branching stems bearing numerous paraphyllia.

Eurhynchium oreganum (Sull.) Jaeg & Sauerb. (*Hypnum oreganum* Sull.) Plants robust, creeping, regularly pinnately branched, 5-25 cm. long; branch leaves ovate, acuminate, serrate, 1-1.5 mm long; apical and median cells similar; capsule horizontal or pendent, ellipsoidal or cylindrical, 2-2.5 mm. long; seta reddish brown, papillose, 2-2.5 cm long; cilia 2-3; spores nearly smooth, 15-20 microns in diameter.

On soil, rocks, logs or bases of trees in woods and thickets.

4. CIRRIPHYLLUM.

Irregularly branched, robust, glossy mosses with creeping stems; leaves ovate or lanceolate, filiform-acuminate, more or less cochleariform; costa single; median cells linear, basal cells shorter and broader; "sporophyte as in Brachythecium except that the operculum is usually long-rostrate."[18]

Cirriphyllum cirrosum (Schwaegr.) Grout, var. **coloradense** (Aust.) Grout. Plants robust; stems stout, erect or spreading, 3-5 cm. long; leaves loosely imbricated, oblong-ovate, 2-2.5 mm. long, entire or nearly so, filiformly acuminate, slightly concave, somewhat plicate; median cells linear, 8-12:1.

On soil in moist woods, Kamiak Butte, *Jones* 860 (sterile).

5. BRACHYTHECIUM.

Stems usually irregularly branched, leafy; leaves usually imbricated, ovate or lanceolate, acute or acuminate, often more or less plicate; stem and branch leaves unlike; costa single, extending to, or above the middle of the leaf; median cells long-rhomboidal; basal cells shorter; capsules often horizontal, or sometimes curved and unsymmetrical, ovoid or ellipsoidal, dark colored; lid conical.

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[18] Grout, Moss Fl. N. Am. 3, pt. 1: 24, 1928.

In this genus the stem leaves and those of the branches are often dissimilar. The term "leaves" refers, in this treatment, to the branch leaves.

- Seta papillose.
  - Leaves acute, apiculate or obtuse, not long-acuminate.
    - Leaves broadly ovate; median cells linear-vermicular ...... *B. illecebrum.*
    - Leaves ovate or ovate-lanceolate; median cells long-rhomboidal ...... *B. rivulare.*
  - Leaves acuminate.
    - Lid conical; median cells 10-15:1; seta 1.5-2 cm. long.
      - Leaves triangular-ovate, 1.5-2 mm. long; alar cells enlarged and inflated ...... *B. Nelsoni.*
      - Leaves ovate-lanceolate, 1-1.3 mm. long; alar cells not enlarged ...... *B. velutinum.*
    - Lid long-beaked when dry; median cells 7-10:1; seta 2-3 cm. long ...... *B lamprochryseum.*
- Seta smooth or nearly so; leaves acuminate.
  - Leaves entire or nearly so, 1.5-2.2 mm. long, costate to beyond the middle; median cells 5-8:1 ...... *B. albicans.*
  - Leaves serrulate or serrate.
    - Leaves 0.5 mm. or less in length, costate to the middle; median cells 3-6:1; monoicous ...... *B collinum.*
    - Leaves 1-2 mm. long, costate to beyond the middle; median cells 8-10:1; usually dioicous.
      - Capsule ovoid, horizontal, 2 mm. long ...... *B. erythrorrhizon.*
      - Capsule cylindrical, curved, sub-erect, 2.5-3.5 mm. long *B. oxycladon.*

Brachythecium illecebrum DeNot., var. **obtusifolium** (Hook.) comb. nov. *Hypnum obtusifolium* Hook., Drumm. Musc. Am. no. 193; *Scleropodium obtusifolium* (Hook.) Kindb., Macoun, Cat. Can. Pl. 6: 202, 1892. As Dr. Grout has indicated in his Moss. Fl. N. Am. 3, pt. 1: 53, 1928, *Scleropodium obtusifolium* (Hook.) Kindb. intergrades completely with *S. illecebrum* (Schwaegr.) B.S.G. It should, therefore, be regarded as a variety rather than as a species. *Scleropodium* appears to be not generically distinct from *Brachythecium.*

Plants irregularly branched, leafless below, light green above; branches julaceous; leaves broadly ovate, cochleariform, apiculate or obtuse, 1-1.5 mm. long, entire, or denticulate at apex; costa stout, sub-percurrent; median cells linear-vermicular, 8-10.1; apical cells broader and shorter; seta 1-1.5 cm. long, purplish; capsule ellipsoidal; lid conical.

On rocks in streams.

Brachythecium rivulare (Bruch.) B.S.G. Plants in robust, thick, spreading mats; leaves ovate or ovate-lanceolate, concave, 1-1.5 mm. long, acute, plicate, more or less denticulate; costa often forked; median cells long-rhomboidal, 6-10:1; apical cells shorter; seta 1.5-2 cm. long, brown, strongly papillose; capsule curved, ellipsoidal; lid conical, acute.

On rocks in streams.

Brachythecium Nelsoni Grout. Similar to *B. rivulare*. Leaves triangular-ovate, long acuminate.

On soil in moist woods.

Brachythecium velutinum [L.] B.S.G. Plants in spreading mats, yellowish green; leaves ovate or ovate-lanceolate, 1-1.5 mm. long, acuminate and usually with a twisted apex, serrate, faintly plicate; costa slender; median cells linear, 10-15:1; seta 1.5-2 cm. long, brownish, strongly papillose; capsule ellipsoidal; lid conical.

In woods, on soil, stones and bases of trees.

Brachythecium lamprochryseum C. Muell. & Kindb. Plants in large loose tufts, yellowish green; leaves ovate or ovate-lanceolate, 1-1.5 mm. long, acuminate with a twisted apex, denticulate, plicate; costa stout; median cells linear-oblong, 7-10:1; seta 2-3 cm. long, brown, strongly papillose; capsule cylindrical; lid long rostrate when dry.

In moist woods, growing on decaying wood.

Brachythecium albicans (Neck.) B.S.G. Slender plants in loose, pale yellowish green, spreading mats; leaves ovate-lanceolate, imbricated when dry, 1.5-2.2 mm. long, slenderly acuminate, entire or nearly so; costa extending beyond the middle of the leaf; median cells linear-fusiform, 5-8:1; seta 1-2 cm. long, brownish, smooth; capsule ellipsoidal; lid conical, acute.

On rocks, soil or bases of trees. Most commonly represented in this area by the

var. occidentale Ren. & Card. which is a more slender, often darker colored plant with loosely arranged, more shortly-acuminate leaves.

Habitat as in the species; also frequently occurring as a weed in lawns in damp shaded situations.

Brachythecium collinum (Schleich.) B.S.G. Plants slender, in thin spreading mats; leaves ovate or ovate-lanceolate, acuminate, imbricated, concave, 0.3-0.5 mm. long, serrate; costa extending to middle of leaf; median cells 3-6:1; seta 0.5-1 cm. long, brown, smooth or papillose; capsule ovoid; lid conical.

On soil and stones in woods and thickets, usually represented in this area by the

var. idahense (Ren. & Card.) Grout, a more robust plant with more or less falcate leaves and longer median cells, 6-8:1.

Brachythecium erythrorrhizon B.S.G. Plants in spreading mats; leaves erect-spreading, often somewhat falcate-secund, 1-1.5 mm. long, lanceolate or ovate-lanceolate, acuminate, serrate above middle, somewhat plicate; costa extending beyond middle of leaf; median cells 8-10:1, linear-vermicular; inflorescence dioicous; seta 1-1.5 cm. long, smooth, brown; capsule brown, ovoid, horizontal, 2 mm. long; lid conical.

var. **suberythrorrhizon** (Ren. & Card.) Grout is monoicous and has narrower, more shortly acuminate leaves.

On soil and stones in moist woods and thickets, not uncommon.

Brachythecium oxycladon (Brid.) Jaeg. & Sauerb. Plants in spreading, yellowish green, shining mats; stems prostrate, irregularly branched; leaves erect-spreading, ovate-lanceolate, 1.5-2 mm. long, acute or acuminate, serrulate, somewhat plicate; costa extending beyond the middle of the leaf; median cells linear, 10:1; inflorescence usually dioicous; seta 1.5-2.5 cm. long, smooth, brown; capsule cylindrical, curved, sub-erect, 2.5-3.5 cm. long; lid long-conical.
On moist cliffs, Almota, *Piper* 250.

6. CAMPTOTHECIUM.

Plants erect or spreading, yellowish green, usually shining, variously branched; leaves crowded, lanceolate, acuminate, strongly plicate; perichaetial leaves usually long filiform-acuminate; costa single, extending above the middle of the leaf; median cells linear or long-rhomboidal, 7-20:1; alar cells usually quadrate; capsule large, cylindrical, curved or erect; lid conical or short beaked.

Scarcely distinct, generically, from *Brachythecium*.

- Capsule erect or nearly so; lid beaked; seta more or less sparsely papillose or nearly smooth; median branch leaves gradually short-acuminate; apical cells oblong or rhomboidal *C nevadense.*
- Capsule curved, seldom erect; lid conical.
  - Seta smooth; stems densely radiculose; plants in dense tufts, growing in bogs or swamps .... *C nitens*
  - Seta more or less papillose; radicles few or none; plants in spreading mats, on rocks, logs or bases of trees.
    - Plants regularly pinnate.
      - Plants stout, coarse; median branch leaves ovate-lanceolate, abruptly short-acuminate or obtuse; apical and median cells linear-vermicular .... *C. megaptilum.*
      - Plants slender; median branch leaves lanceolate, gradually and slenderly acuminate; apical and median cells long-rhomboidal .... *C. pinnatifidum.*
    - Plants irregularly branched.
      - Median branch leaves elongate-lanceolate, with a long slender acumen; apical and median cells narrowly linear; seta strongly papillose .... *C. lutescens.*
      - Median branch leaves lanceolate, gradually acuminate; median cells long-rhomboidal, the apical shorter and broader; seta often indistinctly papillose in the upper half .... *C. aeneum.*

Camptothecium nevadense (Lesq.) Paris. (*Hypnum nevadense* Lesq.) (*Homalothecium nevadense* Ren. & Card.) Plants loosely tufted, 2-4 cm. high, yellowish green; stems prostrate or ascending, irregularly branched; branches upright, arcuate; median branch leaves about 1.5 mm. long, lanceolate, gradually short acuminate, plicate, serrate at apex; margins recurved; costa extending nearly to apex of leaf; median cells linear, 10-15:1; apical cells oblong-rhomboidal; seta more or less sparsely papillose or nearly smooth, about 1.5 cm. long; capsule erect or nearly so, about 2 mm. long, cylindrical; cilia rudimentary or none; lid beaked.

On rocks, common.

Camptothecium nitens [Schreb.] Schimp. (*C. trichoides* (Neck.) Broth.) (*Tomentohypnum nitens* Loeske.) Plants in dense tufts, ascending or erect, densely radiculose, 5-15 cm. high; upper part bright or yellowish green, brownish green below; leaves entire or nearly so, lanceolate, acuminate, crowded, plicate, 3-4 mm. long; angular cells few, short, thick-walled; seta smooth, 2-5 cm. long; capsule cylindrical, curved, reddish brown; lid conical.

In bogs or swamps, not common.

Camptothecium megaptilum Sull. Plants stout, coarse, pinnately branched, 10-15 cm. long; radicles few or none, except at base of stem; branch leaves crowded, imbricated, ovate-lanceolate, strongly plicate, abruptly acute, sharply serrate or serrulate and with recurved margins; median and apical cells linear-vermicular; costa sub-percurrent, toothed on back at apex; seta strongly papillose; capsule cylindrical, curved; lid conical; cilia 2.

On rocks and soil in moist thickets and woods.

Camptothecium pinnatifidum (Sull. & Lesq.) Jaeg. & Sauerb. (*Hypnum pinnatifidum* Sull. & Lesq.) Plants slender, in loose spreading mats, closely and regularly pinnate; median branch leaves lanceolate, gradually and slenderly acuminate, serrate near apex; apical and median cells long-rhomboidal; seta papillose; capsule cylindrical, curved; lid conical; cilia 2.

On rocks, common. A form in which the lid is long beaked occurs on Moscow Mountain. Dr. Grout suggests that it may be a hybrid.

Camptothecium lutescens [Huds.] B.S.G. Plants tufted, ascending or spreading, shining, golden green, irregularly branched, 5-10 cm. long; radicles few or none; leaves 2-4 mm. long, narrowly acuminate to a long, slender, often filiform acumen, deeply plicate; margins recurved below; median cells linear, 10-15:1; apical cells linear; capsule cylindrical, slightly curved, reddish brown; seta distinctly papillose; cilia 1-2; lid conical.

In loose spreading mats on soil, rocks, logs or bases of trees and bushes, local.

Camptothecium aeneum (Mitt.) Jaeg. & Sauerb. (*Hypnum aeneum* Mitt.) Plants in spreading mats, golden green, glossy, irregularly branched; branch leaves 1-2.2 mm. long, lanceolate, gradually acuminate, deeply plicate, serrulate at least at apex; margins somewhat recurved below; apical and median cells long-rhomboidal, the apical shorter and broader; seta indistinctly papillose or nearly smooth; capsule cylindrical, slightly curved, reddish brown; cilia 2-3; lid conic-apiculate.

On rocks, very common, usually sterile in this area.

7. AMBLYSTEGIUM.

Small mosses growing in slender spreading mats; leaves ovate or lanceolate, acuminate, usually imbricated; costa single, or none; cells usually less than 5:1, rhomboidal; seta smooth; capsule usually curved, more or less cylindrical; lid conical.

Leaves costate to middle of leaf.. *A. serpens.*
Leaves costate to above the middle of the leaf............................ *A varium.*

Amblystegium serpens [L.] B.S.G. Plants slender, spreading, branched, dull yellowish green; leaves spreading when moist, usually more or less appressed when dry, entire or nearly so, ovate-lanceolate, acuminate, 0.5-1 mm. long; costa indistinct, extending to the middle of the leaf or beyond; cells irregular, hexagonal-rhomboidal, basal cells quadrate; seta erect, slender, reddish, 1.5-2.5 cm. long; capsule curved, cylindrical; lid conical; calyptra cucullate, whitish; spores brownish, 10-15 microns in diameter.

On soil, stones, usually in thickets, common, fruiting in spring or early summer. Chiefly represented in this area by the forma tenuis [Schrad.] Moenk., which is more slender with narrower leaves and smaller capsules.

ssp. **Juratzkanum** (Schimp.) Dixon. Leaves denticulate, costate to middle, spreading when dry; basal cells rectangular.

Bases of trees, etc., not common.

Amblystegium varium (Hedw.) Lindb. (*A. orthocladon* (Brid.) Macoun & Kindb.) Similar to *A. serpens.* Leaves larger, 1 mm. or more in length, entire or nearly so, costate nearly to the apex; spores yellow, 15-20 microns in diameter.

On bases of trees and bushes, rocks, logs, etc., usually in thickets and moist places.

8. DREPANOCLADUS.

Large bog or swamp mosses with strongly falcate or circinate, slender, acuminate, lanceolate or ovate-lanceolate, mostly entire leaves; costa single, reaching to middle or above middle of leaf; cells long-rhomboidal; lid conical; capsule horizontal, cylindrical.

Plants spreading, tufted, growing on wet logs, rocks or soil in or near streams in woods or thickets; leaves with long, finely filiform acuminate points, more or less crowded.
Angular cells swollen, hyaline; costa ¾ the length of the leaf .... *D. uncinatus.*
Angular cells incrassate, yellowish; costa extending into the acumen .... *D. Sendtneri.*
Plants long, slender, erect or nearly so, growing in bogs or swamps; leaves acuminate, but not finely or filiformly so, distant, usually entire .... *D. aduncus*

Drepanocladus uncinatus (Hedw.) Warnst. (*Hypnum uncinatum* Hedw.) (*Amblystegium aduncum* Lindb.) (*Hypnum aduncum* L., *non* Hedw.) Plants yellowish or golden green; stems more or less tufted, slender, erect or spreading, 4-10 cm. long; leaves crowded, falcate or circinate, oblong or lanceolate, tapering to a long, slender, curved, filiform, more or less dentate acumen, plicate, decurrent and auriculate at base; costa narrow, 30-35 microns wide at base, reaching above the middle of the leaf; capsule sub-erect or horizontal.

On wet rocks, soil or logs in woods or thickets, mostly along or in streams, common, fruiting in summer or autumn.

ssp. symmetricum (Ren. & Card.) Paris. "Leaves moderately striate, capsules narrow, cylindric, always exactly erect, symmetric; setæ sometimes in pairs."[18]

This form was collected by *Sandberg, MacDougal & Heller* at Lewiston and at Farmington Landing in 1892.

Drepanocladus Sendtneri (Schimp.) Warnst. (*Hypnum Sendtneri* Schimp.) (*Amblystegium Sendtneri* Lindb.) Similar to *D uncinatum* but the angular cells are incrassate, yellowish; costa extending into the acumen; capsule sub-cylindrical, sub-erect.

In swamps, rare, frequently sterile. Represented in this area by the forma *aristinervis* Moenk.

Drepanocladus aduncus (Hedw.) Moenk., var. **Kneiffii** (Schimp.) Warnst. (*Amblystegium Kneiffii* B.S.G.) Plants slender; stems 5-30 cm. long; leaves distant, lanceolate, acuminate, entire, 4-5 mm. long, not, or scarcely falcate or secund; margins flat; costa 50-60 microns wide at base, reaching to the middle of the leaf or beyond; capsule horizontal.

In ponds or swamps, common but seldom fruiting.

9. PLAGIOTHECIUM.

Plants loosely tufted, spreading, branched, stoloniferous; leaves complanate or secund, usually asymmetrical, mostly entire, thin, glossy;

[18] Bot. Gaz. 14: 99, 1889.

costa double or none; cells rhomboid-hexagonal or linear, usually chlorophyllose; capsule horizontal to sub-erect, cylindrical, arcuate; lid apiculate or short beaked; peristome double, teeth pale.

Branch leaves distinctly transversely undulate, 3-4 mm. long, ovate, acute, entire or nearly so; capsule 3-4 mm. long, striate when dry; dioicous.......... *P. undulatum.*
Branch leaves not transversely undulate, 1.5-2.5 mm. long; capsule 2 mm. long; autoicous.
  Branch leaves ovate, acute; margins recurved, entire except at apex; capsule striate when dry.......... *P. denticulatum.*
  Branch leaves lanceolate, acuminate; margins plane, remotely denticulate; capsule not striate.......... *P. silesiacum.*

Plagiothecium undulatum [L.] B.S.G. Plants stout, in pale green, prostrate mats; leaves ovate, acute, entire or nearly so, complanate, distinctly transversely undulate, 3-4 mm. long; seta erect, 3-6 cm. high; costa short, double; capsule curved, cylindrical, 3-4 mm. long, striate when dry; lid beaked.

On moist ground and rocks in woods.

Plagiothecium denticulatum [L.] B.S.G. Plants in loose, flat, yellowish green tufts; stems spreading or ascending, stoloniferous; leaves complanate, glossy, ovate, acute, entire except for the slightly denticulate apex, 1.5-2.5 mm. long, one or both margins recurved; cells chlorophyllose, hexagonal-rhomboidal; seta 2.5-6 cm. long; capsule cylindrical, sub-erect, brown, usually somewhat striate when dry, about 2 mm. long.

On rocks and logs in woods, very variable and chiefly represented in this area by the var. microcarpum Ren & Card.

Plagiothecium silesiacum (Beauv.) B.S.G. Plants in loose, flat, yellowish green tufts; stems spreading, irregularly branched; leaves secund, lanceolate, acuminate, serrulate; margins plane; cells linear, 10-15:1, wider at base of leaf; seta erect, 2-2.5 cm. long; capsule curved, cylindrical, smooth, about 2 mm. long.

On decaying logs in woods, fruiting in summer.

10. HYPNUM.

Plants of various habit and branching, usually more or less regularly pinnate; leaves variable, thin, shining, often auricled at the base, often falcate or circinate, mostly ovate-lanceolate, acute or acuminate; costa usually double or none, or sometimes single; cells mostly linear; seta smooth, capsule curved, horizontal or ascending, cylindrical; lid conical or short-beaked; peristome perfect.

Leaves obtuse or shortly acute.
  Leaves firm, erect or imbricated; paludal or terrestrial plants *H. Schreberi.*
  Leaves soft, flaccid, usually secund; rupestral plants.......... *H. ochraceum.*

Leaves usually with a long slender acumen.
Costa short and double or none.
Leaves lanceolate.
Capsule erect, 3-4 mm. long .... *H. subimponens.*
Capsule curved, 1-1.5 mm. long .... *H. circinale.*
Leaves round-deltoid at base .... *H. hispidulum.*
Costa single .... *H. hygrophilum.*

Hypnum Schreberi [Willd.] Schwaegr. (*Entodon.*) (*Hylocomium*) (*Calliergon*) (*Pleurozium*) Plants in large glossy pale green tufts; stems red, erect, rigid, branched; leaves loosely imbricated, obtuse, serrulate at apex, about 2 mm. long, concave, oval-oblong, margins incurved; costa double, very short and indistinct; cells linear, 10-15:1 or shorter and wider at apex of leaf; angular cells quadrate, orange or hyaline; seta red; capsule cylindrical, curved; lid conical.

On soil in woods.

Hypnum ochraceum Turn. (*Hygrohypnum*) (*Limnobium*). Plants in large wide tufts, yellowish green; stems spreading, 5-10 cm. long, irregularly pinnate; leaves falcate-secund, ovate or oblong-lanceolate, sulcate, concave, somewhat obtuse; costa variable, short and double, or single and reaching ½ or more the length of the leaf; cells linear, 8-15:1; basal cells enlarged, rectangular, hyaline; lid convex.

On rocks in streams, very variable, fruiting in summer, or usually sterile.

Hypnum subimponens Lesq. (*Stereodon plumifer Mitt.*) Plants in flat spreading mats, golden green, shining, pinnately branched; stems 5 cm. or less in length; branches 5-10 mm. long; leaves lanceolate, circinate, with a long, slender, filiform acumen, entire or sparingly denticulate above the middle, ecostate; median and apical cells linear; capsule cylindrical, erect or nearly so, 3-4 mm. long; seta 2-2.5 cm. long, smooth; lid conical, 0.75 mm. long; cilia 2.

On rocks and logs in woods.

Hypnum circinale Hook. Plants in spreading, yellowish green mats; stems prostrate, slender, pinnately branched, 5-10 cm. long; leaves circinate, lanceolate, slenderly acuminate, about 1.5 mm. long, ecostate, denticulate at apex; seta 1-1.5 cm. long; capsule curved, ellipsoidal, 1-1.5 mm. long; lid conical, 0.5 mm. long; cilia 1-2.

On trees and logs in mountain woods.

Hypnum hispidulum Brid. (*Chrysohypnum*) (*Campylium*). Plants in loose, flat, yellowish green tufts, radiculose at base; leaves round-deltoid at base, abruptly long narrowly acuminate, serrulate, less than 1 mm. long; costa short and double or none; seta 1.5-2 cm. long; capsule cylindrical, 1.5-2 mm. long.

In swampy places, growing on the ground or on the bases of trees and bushes.

Hypnum hygrophilum Juratz. (*Amblystegium*) (*Campylium*) (*Chrysohypnum*). Plants slender, in loose yellowish green tufts, irregularly branched; leaves ovate, slenderly acuminate, entire; costa single, reaching to beyond the middle of the leaf; capsule cylindrical, curved when dry; lid conical.

In moist places, rare.

11. HYLOCOMIUM.

Plants usually long and robust, variously branched; leaves large, squarrose or secund; cells linear; seta smooth; capsule large, curved; lid conical or short beaked; peristome perfect.

Stems paraphyllose, regularly bi- or tri-pinnate; plants brownish or dark green; stem leaves ovate, acuminate, 1.5-2.5 mm. long, denticulate above; costa short, extending less than ⅙ the length of the leaf; lid beaked............ *H splendens.*
Stems irregularly branched; plants yellowish green; lid conical.
  Stem leaves 2 mm. long, deltoid; stems erect or spreading, paraphyllose; costa short, extending less than ⅙ the length of the leaf............ *H. brevirostre.*
  Stem leaves 4-6 mm. long; costa reaching to the middle or above the middle of the leaf.
    Stems prostrate; paraphyllia present; leaves ovate-lanceolate............ *H robustum.*
    Stems erect or ascending; paraphyllia none; leaves deltoid *H. triquetrum.*

Hylocomium splendens (Hedw.) B.S.G. (*H proliferum* Lindb.) *Mountain Fern-moss.* Fern-like plants in loose, brownish or dark green mats; stems long, trailing, regularly bi- or tri-pinnate, reddish, covered with numerous branched paraphyllia; stem leaves ovate or ovate-oblong, crowded, acuminate, plicate, decurrent at base, 1.5-2.5 mm. long, denticulate above, spinulose-papillose on back; cells linear, nearly uniform, 8-10:1; branch leaves smaller, not plicate, acute; costa short, double; seta reddish, 2-3 cm. long; capsule ellipsoidal-cylindrical, ascending, slightly curved; lid beaked.

Coniferous woods, common, fruiting in spring.

Hylocomium brevirostre [Ehrh.] B.S.G. Plants irregularly branched, yellowish green, erect or spreading, paraphyllose; leaves ovate-deltoid, 2 mm. long; costa double, short, extending less than ⅙ the length of the leaf; capsule ellipsoidal.

Moist woods, local, Spokane Co., and adjoining Idaho.

Hylocomium robustum (Hook.) Kindb. Plants stout, prostrate, yellowish green; paraphyllia present; branches drooping; leaves imbricate, secund, transversely rugose, plicate, scarious, ovate-lanceolate, acuminate, singly or doubly costate to the middle, denticulate near the apex; margins revolute; cells nearly uniform, linear; capsule cernuous, cylindrical; seta purplish; lid conical.

On the ground in coniferous woods.

Hylocomium triquetrum [L.] B.S.G. (*Rhytidiadelphus triquetrus* Warnst.) *Shaggy Moss.* Plants pale or yellowish green in wide tufts or mats; stems stout and rigid, erect or ascending, woody, irregularly branched; paraphyllia none; leaves large, 4-6 mm. long, scabrous on the back, equally spreading, triangular-ovate, decurrent and auriculate at base, acute, plicate, denticulate; costa double, extending to above the middle of the leaf; seta 2.5-3.5 cm. long; capsule ellipsoidal-cylindrical, horizontal; lid short beaked.

Woods, frequently sterile.

Family 17. NECKERACEÆ.

Robust, spreading mosses with primary stems prostrate, and secondary stems erect, horizontal or pendulous, leafy, julaceous or flattened; leaves 8-seriate; costa single, double or none; cells in 1 layer, mostly smooth, upper rhomboidal, lower linear; capsule immersed or emergent, ovoid or cylindrical, erect, symmetrical; peristome double; teeth linear-lanceolate; inner peristome usually from a low basal membrane; processes linear or filiform; calyptra cucullate; lid conical or beaked.

1. NECKERA.

Spreading, yellowish or brownish green, tufted, arboreal or rupestral mosses; primary stems prostrate, leafless; secondary stems pinnately or bi-pinnately branched; leaves complanate, shining, undulate or smooth; cells small, smooth, upper rhomboidal, lower linear, alar quadrate; annulus none; calyptra smooth or villous.

Neckera Menziesii Hook. Plants brownish green, in robust broad tufts; stems 5-20 cm. long with small linear branched paraphyllia; branches flattened; leaves oblong-lingulate, concave, obtuse or apiculate, transversely undulate in the upper half, denticulate at apex, revolute at base on one side; costa strong, single, extending beyond the middle of the leaf; cells rhomboidal; capsule immersed, cylindrical; lid conical.

On rocks and tree trunks, locally abundant. Almota, *Piper* 201; Moscow Mountain, *Geo. Gormo*, May, 1929.

Family 18. FABRONIACEÆ.

Very small, spreading, slender, dark green mosses, with ovate, acuminate leaves; costa single or obsolete; median and upper cells rhomboidal; basal cells quadrate; capsule upright, symmetrical, ovoid or cylindrical, short necked; lid short beaked; calyptra small, smooth, cucullate; peristome single or double; annulus present.

1. FABRONIA.

Smooth, small, spreading, dark green rupestral or arboreal mosses; leaves erect, ovate-lanceolate, dentate or lacerate; costa single, reaching to middle of leaf, sometimes indistinct or absent; lower cells quadrate; upper cells long-hexagonal, chlorophyllose; capsule ovoid, on a short yellowish seta, erect, without neck; lid convex or flat; calyptra small, cucullate; annulus none; peristome simple, orthotrichoid, very hygroscopic.

Fabronia pusilla Raddi. Plants small, grayish green; leaves lanceolate, sharply acuminate, with lacerate-ciliate margins; costa often indistinct or absent; lower cells quadrate; upper cells *rhomboidal*; capsule small, erect, roundish-ovoid; spores papillose.

On moist overhanging basalt at the mouth of Getta Creek, Idaho, in the Snake River Canyon, *Jones* 830. This is the only known station for this plant between California and British Columbia.

Family 19. LEUCODONTACEÆ.

Slender, branching, arboreal or rupestral mosses with ovate or ovate-lanceolate leaves; costa short and double, single, or none; capsule erect, symmetrical, ovoid or cylindrical; seta smooth; calyptra cucullate; peristome double.

1. ANTITRICHIA.

With the characters of the family.

Antitrichia californica Sull. Plants olive or yellowish green, in loose spreading tufts; stems 4-8 cm. long, branched; leaves spreading when moist, broadly ovate, 2-2.5 mm. long, dentate at apex; margins recurved; cells oval or oblong; costa strong, sub-percurrent, sometimes with 1 or 2 short lateral branches at base; capsule cylindrical.

On rocks, not uncommon.

Family 20. FONTINALACEÆ.

Slender, elongated, dark green, aquatic, floating mosses; leaves 3-5 ranked, ovate-lanceolate, entire or nearly so, mostly decurrent; costa single or none; cells smooth, either rhomboidal-hexagonal or linear, prosenchymatous; capsule erect, symmetrical, without neck, immersed or emergent; calyptra smooth, either mitrate or cucullate; peristome double, single or none; outer teeth 16, articulate, inner of 16 cilia, more or less united.

1. FONTINALIS.

With the general characters of the family.

Fontinalis neo-mexicana Sull. & Lesq. Plants brownish green; stems slender, branched, leafless near base, 1-10 dm. long; leaves lanceolate or oblong-lanceolate, decurrent, 2.5-3.5 mm. long, folded; costa none; cells linear; capsule ovoid-ellipsoidal; lid conical.

In woodland streams, floating, and usually attached at the base to rocks.

❦

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Families	Genera	Species
Tetraphidaceæ	1	1
Polytrichaceæ	2	6
Buxbaumiaceæ	1	1
Fissidentaceæ	1	1
Dicranaceæ	3	6
Tortulaceæ	5	10
Encalyptaceæ	1	2
Grimmiaceæ	5	19
Funariaceæ	1	3
Orthotrichaceæ	2	5
Bartramiaceæ	3	3
Aulacomniaceæ	1	1
Timmiaceæ	1	1
Bryaceæ	4	17
Leskeaceæ	5	7
Hypnaceæ	11	41
Neckeraceæ	1	1
Fabroniaceæ	1	1
Leucodontaceæ	1	1
Fontinalaceæ	1	1
20	51	128

GLOSSARY.

Acaulescent. Stemless.

Acrocarpous. With capsules terminal.

Acumen. A slender tapering apex.

Acuminate. Tapering gradually to a point.

Acute. Sharp pointed.

Alar cells. Cells at the basal angles of the leaf.

Annual. Of one year's duration.

Annulus. A ring of cells between the mouth of the capsule and the lid.

Antheridium. The male reproductive organ.

Apiculate With a short abrupt point.

Appendiculate. With short transverse bars.

Appressed. Applied closely to the stem.

Arboreal. Growing on trees.

Archegonium. The more or less flask-shaped female reproductive organ.

Arcuate. Curved; bow-like.

Areolation. The network of cells.

Articulations. Joints.

Auriculate. With auricles.

Autoicous. Antheridia and archegonia in separate inflorescences on the same plant.

Biennial. Of two years' duration.

Bi-stratose. Cells in two strata or layers.

Bryoid. Bryum-like.

Calyptra. The membranous cap on top of the capsule.

Campanulate. Bell-shaped.

Canaliculate Channelled.

Capsule. The fruit, bearing the spores

Cernuous. Drooping.

Chlorophyllose. Containing chlorophyll.

Cilia. Hair-like threads of the inner peristome.

Ciliate. Fringed.

Circinate. Coiled inward.

Clavate. Club-shaped.

Cleistocarpous. Capsule opening irregularly.

Cochleariform. Spoon-shaped.

Collenchymatous. Having the walls thickened at the angles.

Columella. The central axis of the capsule.

Complanate. Flattened.

Convolute. Rolled up.

Costa. Midvein of the leaf.

Cribrose. Perforated.

Cucullate Hood-shaped and split on one side only.

Decurrent. Extending down the stem below the point of attachment.

Deflexed. Bent downward.

Deltoid. Shaped like the Greek letter Δ.

Dendroid. Tree-like.

Dentate. Toothed.

Denticulate. Minutely dentate.

Dichotomous Forked.

Dicranoid. Like Dicranum.

Dioicous. Antheridial and archegonial inflorescences on different plants.

Distichous. In two opposite rows.

Ecostate. Without a midvein.

Ellipsoidal. Shaped like an ellipsoid.

Emarginate. With a shallow notch at the apex.

Emergent. When apices of the leaves reach above base, but not to the top of the capsule.

Entire Without teeth.

Evanescent. Soon disappearing.

Excurrent. Extending beyond the apex.

Exserted With the base of the capsule above the leaf-apices.

Falcate. Sickle-shaped.

Filiform. Thread-like.

Flaccid. Lax and weak.

Flexuose. Zig-zag.

Fugacious. Quickly disappearing.

Gemmae. Small bud-like bodies capable of reproducing the plant.

Glaucous Covered with a bluish white bloom.

Globose Having the form of a globe; globular or spherical or nearly so.

Granulose. Roughened on the surface.

Gymnoporous. With superficial stomata.

Gymnostomous Without a peristome.

Hexagonal Having six angles and six sides.

Hyaline. Transparent.

Hygroscopic Readily absorbing water.

Hypnoid. Hypnum-like.

Imbricated. Overlapping, like shingles on a roof.

Immersed. When the apices of the leaves reach to the top of the capsule.

Immersed. Stomata which lie below the outer layer of exothecium cells.

Incrassate. Thickened.

Inflexed Bent inward.

Inflorescence. The clusters of reproductive organs.

Innovation. A young offshoot from the stem.
Involute. Rolled inward.
Isodiametrical. Having vertical and horizontal diameters equal.
Julaceous. Worm-like, smooth, cylindrical.
Lacerate. Irregularly cleft.
Lamellae. Thin plates.
Lanceolate. Lance-shaped.
Lid. The covering of the mouth of the capsule, the operculum.
Ligulate. Strap-shaped.
Linear. Narrow, with parallel margins.
Lingulate. Tongue-shaped.
Mitrate Mitre-shaped, radially symmetrical.
Muticous Not pointed.
Nodulose. Thickened with small knots.
Oblate spheroidal. A spheroid, flattened or depressed at the poles.
Oblong. Longer than broad.
Obovate. Inverted ovate.
Obtuse. Blunt or rounded at apex.
Opaque. Not transparent.
Orthotrichoid. Orthotrichum-like.
Ovate. Shaped like the longitudinal section of an egg.
Ovoid Egg-shaped.
Paludal. Pertaining to swamps or marshes.
Papillae. Small protuberances.
Papillose Bearing papillæ.
Paraphyllia. Minute foliaceous organs among the leaves.
Paraphyses. Filamentous structures growing among the reproductive organs.
Parenchyma. Tissue composed of cells with truncate ends.
Pellucid. Translucent, but scarcely hyaline.
Percurrent. Ceasing at the apex.
Pericarp The wall of the capsule.
Perichaetial. Special leaves or bracts at the base of the seta.
Perichaetium Involucre surrounding the base of the seta.
Peristome. The fringe of teeth at the mouth of the capsule.
Pinnate. Branched like a feather.
Plane. Flat.
Pleurocarpous. With capsule lateral.
Plicate. Plaited or folded longitudinally.
Porose. With pores.
Processes. The main divisions of the inner peristome.
Prosenchymatous. Having cells with pointed ends.
Protonema. The filamentous phase of the gametophyte.
Pseudopodium A seta-like branch bearing gemmæ.
Pulvinate. Cushion-like.
Pyriform. Pear-shaped.
Quadrate. Square.
Radicles. Root fibrils.
Radiculose. Bearing radicles.
Revolute Rolled back.
Rhomboidal. Diamond-shaped.
Rosulate. Arranged in the form of a rosette.
Rugose. Wrinkled.
Rupestral. Growing on rocks.
Scabrous. Roughened.
Scarious Membranous, not green.
Sclerenchyma. Tissue composed of thick-walled cells.
Secund. Turned to one side.
Serrate Toothed.
Serrulate. Minutely serrate.
Seta. Fruit-stalk.
Setaceous Bristle-like.
Sinuose Wavy.
Spatulate. Spatula-like; obovate above and attenuate at base.
Spheroidal. Having the form of a spheroid.
Spinulose With minute spines.
Squarrose Spreading at right angles from the stem.
Stolon. A slender creeping secondary stem.
Stoloniferous. Bearing stolons.
Stoma (ata). Openings in the epidermis.
Stomatose Bearing stomata.
Stratose. Arranged in distinct strata.
Striate Marked with striæ or fine lines.
Striolate. Finely striate.
Strumose. With a swelling at the base on one side.
Sub-percurrent. Ceasing below the apex.
Subulate. Awl-shaped.
Sulcate. Furrowed.
Superficial. Stomata which are on the same level as the outer layer of exothecium cells.
Synoicous. Having the antheridia and the archegonia in the same cluster.
Terrestrial. Growing on soil.
Truncate. Ending abruptly.
Turgid. Swollen.
Undulate. With a wavy surface.

Unistratose. Cells in one stratum or layer.

Urceolate. Urn-shaped.

Vermicular. Worm-shaped.

Villous Bearing long hairs.

Whorled. Arranged in a ring.

EXPLANATION OF ABBREVIATIONS OF AUTHORS' NAMES.

AUST.	Austin, Coe Finch.
BEAUV.	Beauvois, A.M.F.J. Palisot de.
BEST	Best, G. N.
BLAND.	Blandow, Otto C.
BRAITHW.	Braithwaite, R.
BRID.	Bridel, Samuel E.
BROTH.	Brotherus, V. F.
BRUCH	Bruch, Phillip.
B.S.G.	Bruch, Ph., Schimper, W. Ph. & Guembel, Th.
BURCH.	Burchell.
C. M. & KINDB.	Mueller, Carl, & Kindberg, N. C.
CARD & THER.	Cardot, J., & Theriot, J.
C. MUELL.	Mueller, Carl.
DE NOT.	DeNotaris, Guiseppe.
DICKS.	Dickson, James.
DILL.	Dillenius, Johann Jacob.
DIXON	Dixon, Hugh Neville.
E. G. BRITT.	Britton, Elizabeth Gertrude.
EHRH.	Ehrhart, Friedrich.
FRYE	Frye, Theodore Christian.
FUERNR.	Fuernrohr.
FUNCK	Funck, Heinrich C.
GREV.	Greville, Robert K.
GROUT	Grout, A. J.
GUNN.	Gunnerus, Johann E.
H. & H	Hoppe & Hornschuch.
HAMM.	Hammar, O.
HAMPE	Hampe, Ernst.
HARTM.	Hartmann, Carl Johann.
HEDW.	Hedwig, Johann.
HEDW. f.	Hedwig, Romanus Adolf (the son).
HOBK.	Hobkirk, C. P.
HOFFM.	Hoffman, Georg Franz.
HOLZ.	Holzinger, John M.
HOOK.	Hooker, William Jackson.
HOOK & TAYL.	Hooker, W. J., & Taylor, Thomas.
HORNSCH.	Hornschuch, Christian F.
HUDS	Hudson, William.
HUEB.	Huebener, J. W. P.
HUSN.	Husnot, T.
JAEG. & SAUERB.	Jaeger & Sauerbach.
JENNINGS	Jennings, Otto E.
JURATZ.	Juratzka, J.
KINDB.	Kindberg, Nils Conrad.
L.	Linnaeus, Carolus.
LAG.	Lagasca, Mariano.
LEIB.	Leiberg, John B.
LESQ.	Lesquereaux, Leo.
LESQ. & JAMES	Lesquereaux, L., & James, T. P.
LIMPR.	Limpricht, K. Gustav.
LINDB.	Lindberg, Sextus Otto.
LOESKE	Loeske, Leopold.
MACOUN & KINDB.	Macoun, John, & Kindberg, N. C.
MENZ.	Menzies, Archibald.
MITT.	Mitten, William.
MOENK.	Moenkemeyer, Wilhelm.
NECK.	Necker, Noel Joseph de.

NEES	Nees von Esenbeck, Christian Gottfried.
NEES & HORNSCH.	Nees & Hornschuch.
PARIS	Paris, E. G.
RABENH.	Rabenhorst, Ludwig Christian Gottloeb.
RADDI	Raddi, Guiseppe.
REN. & CARD.	Renauld, F., & Cardot, J.
SCHLEICH.	Schleicher, Johann.
SCHRAD.	Schrader, Heinrich A.
SCHREB.	Schreber, Johann D. C. von.
SCHWAEGR.	Schwaegrichen, Christian Friedrich.
SIBTH.	Sibthorp, John.
SCHIMP.	Schimper, W. Ph.
SM.	Smith, James Edward.
SULL.	Sullivant, William Starling.
SULL. & LESQ.	Sullivant & Lesquereaux.
SW.	Swartz, Olaf.
TAYL.	Taylor, Thomas.
TIMM	Timm, Joachim C.
TURN.	Turner, Dawson.
VENTURI	Venturi, C. G.
VILL.	Villars, Dominique.
WAHL.	Wahlenberg, Georg.
WARNST.	Warnstorf, Carl.
WEB.	Weber, Friedrich.
WEB. & MOHR	Weber, F., & Mohr, M. H.
WILLD.	Willdenow, Karl Ludwig.
WILLIAMS	Williams, Robert Statham.
WILS.	Wilson, William.
ZETT.	Zetterstedt, Johann E.

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